Agricultural Operations
in India,
Review
1919-20 to 1922-23

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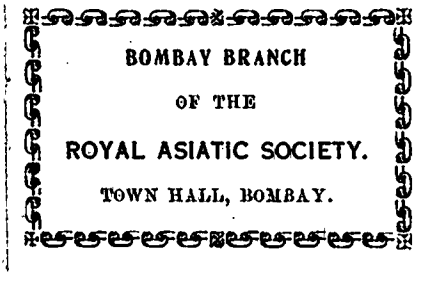


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# Review of Agricultural Operations in India

1919-20 to 1922-23

134282

CALCUTTA
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This annual publication has hitherto appeared under the title "Progress of Agriculture in India." It has, however, been felt that the term "progress of agriculture" is somewhat misleading, as it is only possible in a publication of this nature to review briefly and in a very general way some of the more important items of work of the various Agricultural Departments in India. The title of the report has therefore been changed to "Review of Agricultural Operations in India." Some rearrangement of the subject matter has been made in order to minimize repetition and in order to permit of reference to particular subjects without having to wade through the rest of the report. This has allowed a cutting down of the chapter on District Work, a subject which, although of great importance to Provincial Agricultural Departments, is not of equal interest to the general public.

PUSA,
*January 16th, 1921.*

S. MILLIGAN,
*Agricultural Adviser to the Government of India.*

## ERRATA.

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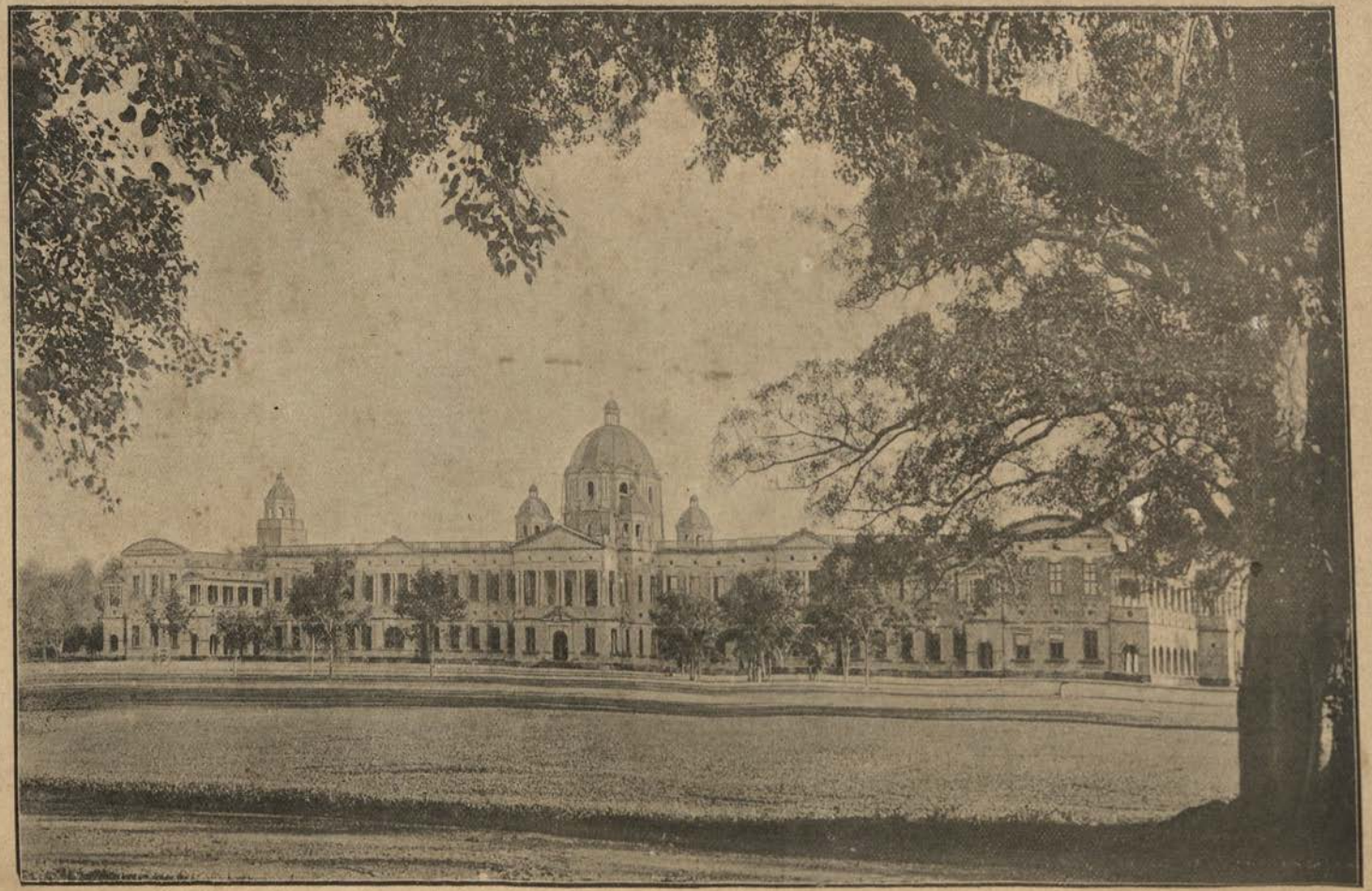

THE AGRICULTURAL RESEARCH INSTITUTE, PUSA

# Review of Agricultural Operations in India 1919-20

## CHAPTER I.

### AGRICULTURAL CONDITIONS OF THE YEAR.

During the year 1919, the monsoon rains began at about the normal time, but ceased in Northern India somewhat earlier than usual. The period June to September was characterized by rainfall rather above normal. Over India the season was thus favourable from an agricultural point of view in marked contrast to that of the previous year. In Burma, however, the excellent promise proved delusory and nearly every crop turned out badly.

The total yield was much higher in the case of all crops except *tea* and *indigo*, while the average outturn per acre of all crops, without exception, was much above the average of the last 10 years.

With continued high prices for agricultural produce, the year was thus a prosperous one for the agriculturist whose purchasing power kept pace with the rising cost of other necessaries of life. Further, there was no lack of employment for agricultural labourers who, on the whole, were able to command good wages.

The year was not, however, so suitable for live stock. In several provinces contagious diseases prevailed in a virulent form, and the reported number of deaths was higher than in the preceding year. The supply of fodder was, however, better on account of the favourable agricultural year.

## CHAPTER II.

## ECONOMIC WORK ON CROPS.

The reviews of the last few years have shown how the Agricultural Department, with a depleted superior staff and increasing commitments, has attempted to meet the agricultural situation caused by the war.

The serious interruption to investigation on the Government farms has led to concentration on spreading the results of the work of previous years, the outward effects of which are to be seen mainly in the great extension of the area under improved varieties of crops and an extended use of those simple cultural implements introduced at the Government farms before the war.

Enormous in the aggregate although the areas under improved varieties of crops undoubtedly are as a result of a few years' work, they are trifling compared with what can and will be done in the future, when the efforts of plant-breeding in combating disease bear full fruit and when special varieties of crops are fitted into the special conditions suited to their qualities. The very success, however, of the plant-breeding operations in India has undoubtedly led to a neglect of the provision of an adequate staff for the complete study of the relations between soil and crops, a knowledge of which is the main essential to real agricultural progress. Agricultural investigation has up to date been mainly statistical, requiring a large number of experiments in each case to cover the probable error. Much work of this nature has already been done, but the evolution of a rational system of agriculture could be immensely assisted by groups of specialists working on the various crops under the varying conditions to be met with in India.

***Rice.*** Of all the crops grown in India, rice stands an easy first in importance. No other single crop occupies a larger area or is used as a staple food by a greater percentage of the vast population of the country.

The total estimated area under rice in 1919 was 78,394,000 acres as against 77,019,000 acres* in the preceding year,

*Revised figures.

yielding 34,199,000 tons of cleaned rice as compared with 24,201,000 tons* in 1918-19. The estimated yield per acre of the crop was 977 lb., or 273 lb. more than that of the previous year and 59 lb. above the last decennial average. The improvement of the yield of this crop still forms one of the main items of work of the Agricultural Department in India. A brief account of the work in hand is given below.

The crop covers over 20,000,000 acres in **Bengal**. Much progress has already been achieved towards the ultimate improvement of the crop. Several heavy-yielding pure races of transplanted paddy, recently isolated by the provincial Economic Botanist, are still under trial on a field scale against the Indrasail variety which up to date has been the best of the departmental selections. One of these, Dudhsar, a race almost exactly similar to Indrasail, this year gave a slightly higher yield and ripened about a fortnight earlier. Should further tests confirm these results, this race will undoubtedly prove valuable for tracts where moisture is deficient towards the end of the season. Further attempts are in progress to combine, by crossing, early maturity and heavy yield in one plant. Pure lines of deep water *aus* and *aman* paddies have been isolated, and investigations into the physical factors affecting their yield and water requirements have been started. A large amount of work is being done on the inheritance of characters, particularly with reference to their combination. Further work in progress includes a study of the transpiration of early and late types of *aus* and *aman* paddies.

Of the *aus* paddies, the department's selection, Kataktara, continued to give excellent results in Eastern Bengal as a broadcast paddy, while in the Bankura District in West Bengal it proved successful when grown as an early ripening, transplanted variety.

Both the Indrasail and Kataktara varieties continued to grow in popularity in the districts. About 172 tons of seed of the former were distributed in 10 lb. lots on the condition of an equivalent amount being returned after harvest. The demand for seed of Kataktara far outran the supply. The natural spread of both varieties was, however, severely handi-

*Revised figures.

capped by the scarcity and high prices prevailing during the year. The system of distributing seed in small packets has proved itself much more efficient than sale in the ordinary way.

In **Madras**, as in Bengal, rice is the chief crop dealt with by the Economic Botanist, and in that province too excellent results have been obtained through the isolation of high yielding strains. In the varietal tests conducted on an extensive scale at Coimbatore, the best yield was obtained from the strain Sadai Samba, amounting to no less than 3,771 lb. per acre, representing a net profit of Rs. 229 per acre for the crop. Selections Nos. 24 and 1303 grown on a larger scale also did well, the latter proving slightly superior. The colour of the rice from No. 1303, however, varies considerably, and a number of selections have therefore been made and examined with the object of eliminating this defect. A cross between Tulukka Samba and Kichili Samba No. 24 was made with the object of combining the high yield of the local variety with the uniformity, non-shedding and early ripening qualities of No. 24. Puttu paddy was introduced for the first time and grew well, yielding 2,093 lb. of grain and 3,082 lb. of straw per acre. Its black colour and pasty nature when cooked, however, form serious objections to its general use.

In **Burma**, the selection Ngasein 10 and Ngasein 2104 continued to maintain popularity and were in great demand for distribution. The yield of the latter averages some 8 to 10 baskets of 51 lb. each more per acre than the best local varieties. The area under this strain rose to some 60,000 acres in the three districts of Mandalay, Kyaukse and Shwebo. For local milling and consumption, and as a fine quality export rice, Taungteikpan 17 was in strong demand, while Ngachima proved popular with cultivators as a good paddy for high, sandy land. This variety is also highly esteemed for white rice hulling. Some of the smaller mills are reported to have again given a premium for these varieties. The large mills are also prepared to pay a premium for good quality paddy, provided the grain is supplied in quantities sufficient to admit of separate storage and milling. The trade in parboiled rice is expanding rapidly, and the question of the varieties of paddy most suitable for this purpose is being investigated. The

selections which have passed out of the trial stage this year and are being distributed are Letywezin Nos. 25 and 26 and Ngachima C 59. These are paddies of medium growth period suitable for white rice milling.

Grouping and nursery experiments again demonstrated the value of light seeding combined with the transplanting of singles and doubles. It is estimated that by the adoption of this method at least 60 to 70 per cent. of paddy ordinarily used as seed might be saved.

The year's results in the **Central Provinces** indicate the prospects of improved and intensive cultivation of rice in the Chattisgarh Division. The net profit of growing Luchai, Chinoor and Gurmatia as late, Parewa and Bhondu as medium, and Halvi and Bhata Gurmatia as early varieties ranges to upwards of Rs. 130 per acre at the present scale of prices. The results of continued experimental work indicate that for the variety Gurmatia the largest outturn is obtained when the seedlings are transplanted four inches apart singly or six inches apart by twos or threes. The high yielding paddy No. 17 which, owing to its early maturing quality, affords opportunity for double cropping, promises to be of considerable value in the Jubbulpore Division.

A successful instance of the transference of a crop from one piece of land to another as a manure comes from the Central Provinces. A crop of sann-hemp grown on rice fields was transferred to an adjacent piece of *rabi* land. It was found that 4,000 lb. of sann-hemp, applied in this way annually for four years, produced an increase of 1,000 lb. of grain per acre over the unmanured plot, a similar quantity of cattle dung giving an increase of only half that amount. The principle involved is one of considerable importance in maintaining soil fertility and has been under experiment at Pusa for some years.

In **Assam**, single plant selections from 56 varieties of *aus* and 105 varieties of *sail* paddy were under observation. Three of the most promising selections of *aus* and four of *sail* were further tested. Amongst the latter, Bengal Indrasail came out as the highest yielder with an outturn of 2,546 lb. per acre. A yield of 2,364 lb. was obtained from Latisail, while George-

sail yielded 2,230 lb. per acre. In some parts of the province, in Kamrup, for instance, the average yield of Indrasail in the fields of the ryots exceeded that of the local varieties by 337 lb., and that of Georgesail by 284 lb. per acre. Arrangements have been made to deal out 6,800 lb. of the former and 1,760 lb. of the latter for demonstration and distribution in 10 lb. packets. The *aus* paddies, however, call for further trials, and the department is as yet unable to recommend any variety for extensive cultivation. Experiments with flood resisting varieties and selection of *asra* and *boro* paddies have been taken up.

In **Bihar and Orissa**, the work on this crop was continued on the lines of previous years. Out of a large number of single selected plants, several distinct types have been isolated; one of these seems to be very promising and is being multiplied for an extensive trial. Of the imported varieties, Luchai and a fine *aus* from the Central Provinces were found to be more profitable at Cuttack than any of the local varieties of their class. A useful earlier variety of paddy, Dahia, has been brought into prominence by trials on the Sabour farm, and is in strong demand in Bhagalpur Division.

In the **Bombay** Presidency, the work on pure line strains of paddy is in progress and selections are being narrowed down. Meanwhile, seeds obtained by mass selection are in considerable demand.

In the **Travancore State**, experiments designed to improve the quality by selection, to reduce the seed rate and to improve cultural operations are in progress. The experimental cultivation done by the State during the last three years has convinced the cultivators of Kuttanad that a crop can be successfully raised annually on the *punja* rice lands that are now cultivated only once in two years, and 3,000 acres of this class of land have been brought under annual cultivation.

Amongst the **diseases of paddy**, Ufra received a good deal of attention. The disease is caused by an eel-worm (*Tylenchus angustus*) and appears towards the end of the rains. The tips of the leaves of plants affected turn brown, the ears which are just forming follow suit, the plants wither, and the outturn is seriously reduced. The disease is serious in the low-lying areas of Eastern Bengal. Experiments have, however, proved

that it can be controlled if thorough drainage can be provided so as to dry up all the lower parts of the *bhils* from which infection spreads. An investigation is now in progress to see how far it will be possible to effect this in Faridpur District which is particularly badly affected by Ufra.

Further investigations have been made into the blast of paddy (*P. oryzæ*). Similar diseases have been found on Ragi (*E. coracana*), Tenai (*S. italica*) and wheat. While the blast of paddy, *ragi*, *tenai* and ginger grass could infect both wheat and barley, they could not infect each other.

The borers are the most destructive of all **insect pests attacking rice,** and the annual loss due to them is very large. Investigations relating to them are in progress at Pusa. Two of the other pests, Rice Hispa and Rice-bug, were combated in Assam by the use of hand bags. An extensive campaign was carried out in Madras against the swarming caterpillar (*Spodoptera*) which committed havoc on paddy in the Malabar District.

***Wheat*** stands next to rice in the list of crops grown in India. The area rose from 23,798,000 acres* in 1918-19 to 29,976,000 acres in the past year, and the estimated total yield from 7,508,000 tons* to 10,092,000 tons. The production was 34 per cent. higher than in 1918-19, the outturn per acre showing an increase of 47 lb. and 58 lb. as compared with that of the previous year and the average of the preceding ten years.

As pointed out in last year's report, the work of the Agricultural Department in connection with this crop consists not only in the evolution, trial and distribution of strains of superior yielding power, quality of grain, strength of straw and resistance to rust, but also in demonstrating the response of the crop to better cultivation. Amongst the types distributed for extensive cultivation, Pusa 4, Pusa 12 and Punjab 11 have continued their natural spread in the localities suited to their qualities. The fact that several of the Pusa wheats are winning prizes in foreign countries and establishing themselves there is another testimony to their intrinsic value. During the

*Revised figures.

year under review, Pusa 4, grown at Gilgandra, in Australia, gained the first prize in the strong white class at the Royal Agricultural Show held at Sydney, and was awarded 92·5 points out of a total possible of 100. The report states that " it yielded a high percentage of excellent colour flour of 53 quarts to the sack strength, which was the highest water absorption of all the flours tested in the competition."

Pusa 53, a new rust-resistant wheat produced by the Howards by crossing on P 6, is still under trial at the central station. Others have been under trial at Cawnpore, Kalianpur and Shahjahanpur, and it is reported that most of them promise well.

Experiments designed to test the effect of irrigation and cultivation on yield and quality at Shahjahanpur and at Nawabganj (Bareilly) show that, even after a heavy crop of sugarcane, with the correct preliminary cultivation, a crop of about 49 bushels per acre of Pusa 12 can be obtained with one irrigation of four inches in November.

Under a system of Government advances, some 1,070 tons of Pusa wheats 4 and 12 were distributed in the **United Provinces**. This, however, affords no indication of the extent to which these wheats have spread in these provinces. They are now to be found in every district. The number of villages growing practically no other wheat is increasing steadily, and these in turn are acting as centres for natural extension. An increasing number of zemindars are also growing considerable areas on their own land, and in this way a net-work of local seed farms is gradually being built up. In Bundelkhand, Pusa 4 has again been a marked success on the Ken Dhasan and Betwa canals. C 13 wheat was tried at the Partabgarh farm on a large scale, and gave an average outturn of 2,798 lb. of superior wheat and 5,993 lb. of *bhusa* per acre.

The improved wheats fetch a high premium in the local markets for export to Bombay. Unfortunately they are usually exported mixed with 30 to 50 per cent. of local *deshi* wheat.

In the canal colonies of the **Punjab**, the estimated sowings of Punjab 11 amounted to 377,500 acres during the year as against 302,500 and 196,500 acres in the preceding two years, while 675 acres are reported to be under Punjab 8 A and 70

acres under Pusa 12. In the *barani* tracts, Pusa 12 is gaining ground. This wheat ripens a fortnight earlier than the Punjab types and requires less water than many. It is also popular in the Hill States, and at least in one of them—Sirmoor—it is likely to be the only wheat grown in a few years' time. Punjab 8 A is apparently better liked in the more humid tracts. Trials on the Lyallpur farm indicate that Punjab 11 and 8 A run one another very close in point of yield, under local conditions. The latter, however, appears to have the advantage at Gurdaspur and Hansi. This year the remarkable yield of 43 maunds equivalent to nearly 57 bushels per acre—so far we know a record figure for the Punjab—was obtained at the Lyallpur agricultural station.

On the Peshawar farm in the **North-West Frontier Province**, the Australian wheat Federation again gave better results on rich soils than Pusa 4, the maximum yields being 2,800 lb. and 1,600 lb., respectively. Pusa 4, however, responds remarkably well to judicious irrigation, and it has, therefore, been taken up by cultivators possessing good irrigated land. It was harvested on no less than 40,000 acres during the year under review, and is estimated to yield about 160 lb. per acre more than the local wheats replaced. On the merits of the Australian wheat, the Agricultural Officer of the province remarks that "on the very best irrigated land under really good cultivation, Federation can positively be depended on to yield an *upstanding* crop of over 30 maunds (2,400 lb.) per acre in almost any year."

In the **Central Provinces**, the Muria-khapli crosses, Nos. A 112, A 113 and A 115, did well in the variety tests on the Hoshangabad farm, yielding between 650 and 700 lb. of grain per acre. When irrigated and manured, the Central Provinces wheats AO 95, AO 89 and the Pusa wheat 100 all gave outturns of over 800 lb. per acre on the Raipur farm, while under similar conditions AO 89 and Pusa 110 gave good results on the Tharsa farm.

The Pissi wheat AO 85, which promises to become the standard variety of Betul District, continued in strong demand. Sukarhai Pissi, Pusa 12 and Pusa 100 are gradually replacing the local varieties in the Chattisgarh Division. The manurial

experiments for irrigated wheat showed no definite financial benefit from the use of either organic or inorganic manures. Wheat grown under irrigation as a second crop to groundnut is a rotation strongly recommended by the department for adoption in Nagpur, Bhandara and Balaghat Districts.

In **Burma**, macaroni wheat was again grown successfully at Mandalay and at the farms in Shwebo District, while bread wheat was confined to the Southern Shan States and the Namyin valley, Myitkyina. Two of the heavy-yielding selected strains of macaroni wheat are being multiplied with the co-operation of cultivators. In Shwebo District alone, where a few years ago the crop was almost unknown, the area under this variety increased by 2,150 acres during the year. Several useful strains of bread wheat have been isolated from the local mixed varieties. Two of these promise to be as good as the best exotic strains Federation, Pusa 4 and Pusa 6, which averaged 2,180, 1,820 and 1,740 lb. per acre. It is also worth recording that these yields followed a crop of potatoes, from a type of land which would, in the ordinary course, have long ago been abandoned by the cultivator. The results clearly indicate good prospects for wheat cultivation in the Southern Shan States.

In **Bihar and Orissa**, Pusa 12 is now thoroughly established in the Nawada Sub-division of Gaya as well as over parts of Shahabad and Patna *diaras*.

Punjab 11 and Pusa 12 wheats have been introduced into **Sind** and have attained considerable popularity. The Plant-breeding Expert to the Government of Bombay is engaged on work on pure line strains of wheats and is narrowing down his selections.

In the **Baroda State**, Pusa 4 and 12 have been found to be about equal to the local types in yield, but as the higher price fetched by the improved varieties brings in a difference of about Rs. 5 per acre to the cultivator, it is expected that their cultivation will extend rapidly.

***Sugarcane.*** The estimated total area under this crop during the year was 2,645,000 acres compared with 2,861,000 acres* in the preceding year. The season was, on the whole,

*Revised figures.

favourable, the estimated yield (2,989,000 tons) being 27 per cent. above the final figure (2,359,000 tons) for 1918-19. The average yield of *gur* (unrefined sugar) per acre worked out at 2,531 lb. as against 1,847 lb. of 1918-19 and 2,310 lb., the average of the preceding ten years.

Before the war India was importing 900,000 tons of sugar annually. During the year under review this had fallen to 408,700 tons, excluding molasses and confectionery, but the value of the import was Rs. 21,84 lakhs compared with Rs. 15,37 lakhs. In spite of high prices, the indigenous industry failed to respond by an increased area under the crop, indicating some inherent obstacles to expansion. What these are will presumably be fully elucidated by the Indian Sugar Committee whose report is at present in the press, but it is almost certain that one of the chief of them is the want of capital to finance labour and provide manure and irrigation. The appearance at this juncture of a large concern like the Indian Sugar Corporation with a capital of five crores of rupees is to be welcomed by all who possess the desire of rendering India less dependent on imported sugar. The establishment of a Sugar Bureau at Pusa with the object of furnishing advice to cultivators, manufacturers and capitalists has been found useful. The Secretary is in touch with nearly all the sugar experiment stations of the world and with the principal sugar machinery manufacturers in Great Britain and the United States of America. The Bureau has collected a mass of valuable information regarding the industry which is much sought after.

The existing situation lends special interest to all experimental work on sugarcane.

Over half of the total area under the crop in British India is grown in the **United Provinces**. Experimental work was continued at the Shahjahanpur Research Station, and the propagation and distribution of tested varieties were carried out on the district farms. Trials of three new varieties from the central station have given very promising results at Hardoi and Etawah, particularly when sown after a rains fallow. Progress has been made with the extension of sugarcane cultivation

on the irrigated areas. Large areas in Oudh and Bundelkhand are eminently suited for cane, provided sufficient water supply is assured. The possibilities of sugarcane cultivation with an adequate water supply in a suitable tract are well illustrated by the outturns from Hardoi farm, where the yield of cane reached over 35 tons, the yield of *gur* 4½ tons and the value thereof Rs. 1,200 per acre. Excellent results were also obtained at Shahjahanpur with improved methods of cane cultivation.

The small Government factory at Nawabganj was again run during the season at a slight loss.

In the **Punjab**, in trials made at Ferozepur the yield of *gur* obtained from Saretha cane was much in excess of the yield of local Katha cane. At Lyallpur, as much as 77½ maunds or nearly 3 tons of *gur* were obtained from one of the Saretha plots. On the Gurdaspur farm, No. 202 proved to be the best of the Coimbatore canes.

In **Bihar and Orissa**, work on this crop has been started on all the farms of the department. Experiments have proved that the outturn from the ordinary local varieties, grown on average undrained paddy land, can be doubled by drainage where this can be effected. A crop of over 35 tons giving over four tons of *gur* per acre of J 247 was grown on drained paddy land without irrigation at Ranchi. There seems no good reason why heavy yields of cane should not be obtained over a great part of South Bihar wherever subsoil water can be kept below the surface by open drains.

Some of the new seedling canes from the Coimbatore station gave very large yields on small plots at Sipāya where experiments with the object of finding stronger growing varieties of high sucrose content are in progress. (Plate I.)

In Orissa, the expansion of the area under Mungo sugarcane continued to progress satisfactorily. The efforts of the department are being confined to the distribution of this variety over areas hitherto unexploited.

The results of the experiments at Sabour seem to indicate that there are a number of good indigenous varieties which are interchangeable under normal conditions. Seven of these gave an outturn of *gur* of more than two tons per acre.

CO 215 CO 208 CO 202

CO 202 CO 201

Coimbatore seedlings at the Cattle-breeding Station, Sipaya.

Note the free growth and satisfactory habit. The gauge seen in the pictures has alternate foot spaces marked black and white and is placed to enable comparison of height of growth.

In **Bengal**, the experiments with different varieties of sugarcane received an unfortunate set-back through the cyclone which created great havoc on the Dacca farm in September 1919. Several new exotics from Australia, Java and Demarara have, however, been obtained, and are being multiplied for comparative tests. At Rajshahi, the Tanna canes again led the way and justified their selection for distribution. Similar results were obtained at Chinsura where the superiority of Yellow Tanna was very marked. Practically five tons (137 maunds) of *gur* per acre were obtained from one plot at the latter farm, while the average yield over 13 plots was 3·8 tons (108 maunds) per acre.

In **Bombay**, improvement has been introduced in almost every detail of the tillage, manuring and watering of the cane and the handling of the produce. New sugarcane varieties suited to various tracts and conditions are coming into common use and are being widely distributed.

In **Madras**, the most important work on sugarcane is being carried on on the Sugarcane-breeding Station at Coimbatore, which supplies India with seedlings. The total number of seedlings raised during the year was 6,200. Seedlings distributed from the station are found to grow readily in Northern India, and the centralization of cane-breeding in the Madras Presidency has proved satisfactory. Increased attention is now being paid to the sucrose content of the seedling canes.

On the presidency farms, cultural, varietal and manurial experiments were continued. CO 1, a seedling cane from the Sugarcane-breeding Station, Coimbatore, apart from giving the heaviest yield and the excellence of its *jaggery* (unrefined sugar), was not attacked by jackals, a great asset in any variety. The exotic Java 247 from the same station was tried at Nandyal, Sirval and Hospet. In the two first-named places it was a success, but the result at Hospet was disappointing.

In **Assam**, much useful work has been done in selecting and establishing good varieties of sugarcane. The better kinds of cane are much appreciated by growers and a large number of setts were distributed during the year. J 33*a* was distributed for the first time. Owing to its hard rind, it is not likely to

suit wooden mills, but the time has gone for catering for such. Ten varieties were grown experimentally. The average yield for the ratoon crop was 22 tons stripped cane per acre, while the plant cane gave a 39·5 tons average on the phosphated area as against 37·5 tons for the unphosphated area. In the ratoons, J 33*a* gave the largest crop and returned the highest yield of sucrose in extracted juice. Of the plant canes, B 147, B 376 and Striped Mauritius continued to yield very heavy crops, as did some of the newer importations, for instance, Barbados A, B 3412, and J 33 *a*, but the quality of juice was below standard. Barbados A returned the biggest crop, the average for four plots being 50·5 tons per acre. Thirty new varieties were grown for observation, some of which showed exceptional promise as croppers or quality canes or both combined. These have now been introduced into variety trials. The growing of sugarcane and manufacture of white sugar on a commercial scale at the Kamrup farm was continued. The season was again unfavourable, germination was none too good and, to add to the troubles, a devastating epidemic of beetles attacked the young crop and damaged large sections of it. The crop was, therefore, a short one, and the factory worked for about a month only. The average extraction in the factory was about 68 per cent., the juice showing an average purity of just under 90 per cent. In deference to unofficial opinion in the Provincial Legislative Council, which was unfavourable to the retention of the farm by Government, it was handed over to the Managing Agents for the Assam Sugar Estates and Factories on the 1st April, 1920. It is hoped that the extensive manurial experiments and comparative tests initiated by the department will be continued by the company.

The experiments on the Peshawar farm in the **North-West Frontier Province** indicate that Barbados 256 and Assam Red are far more vigorous growers and heavier yielders than the local Paunda. Both of them require less irrigation than the local variety. The rind of the Barbados variety splits badly, but Assam Red has not shown any such defect.

In the **Central Provinces**, out of the varieties tried on the Chandkhuri farm, Khari gave the highest yield, showing a net profit of Rs. 219 per acre. On the Sindewahi farm, over a

period of seven years this variety has given an average of about one ton more *gur* per acre than the local varieties, Kala and Katai, and is thus in great demand in that locality. In the year under review, the net profit per acre obtained by the cultivation of Khari cane at Sindewahi reached the high figure of Rs. 1,200 with *gur* selling at 6 lb. per rupee. Other varieties which have done well are Sunnabille and Mauritius 16, also some of the Coimbatore seedlings. After six years of experiment, the limit to the economic application of farmyard manure to the sugarcane crop has not yet been reached, each successive increment having shown a profit.

In **Burma**, the most promising work done by the department during the year was in the Namyin valley, Myitkyina District, where experiments demonstrated that Striped Mauritius and Gilman produced at the rate of 40 tons of cane (upwards of four tons of *jaggery*) per acre. These varieties are being multiplied for trial on a field scale; meanwhile, five lakhs of cane setts have been distributed to cultivators in the neighbourhood. Further experiments with exotic varieties were made at Singaing in Kyaukse District. Of these, Gilman and B 376 were successfully grown. At Hmawbi, the Ashy Mauritius variety did best. The department has succeeded in stimulating the interest of Kachins in the cultivation of sugarcane and manufacture of *jaggery*. There appears to be some scope for cultivation of sugarcane on a factory scale in Burma, and steps have been taken by more than one firm to secure tracts of sugarcane-growing land and to erect machinery for the conversion of *jaggery* into sugar.

In **Mysore**, Red Mauritius continued to give the highest yield on the State farm, J 33*a* coming next. Several of the seedling varieties from Coimbatore gave a higher outturn than Red Mauritius, but these will have to be tested on a larger scale before definite conclusions can be arrived at. In the spacing experiments, crops grown in rows four feet apart continued to give as large outturns as those at three feet apart. This is important, as wider spacing will, in addition to effecting a considerable saving in seed and cultivation expenses, be of great importance to cultivation by tractors on estates growing sugarcane on a large scale.

In the **Travancore State**, the variety trials and manurial experiments were continued. B 208, B 147 and Pundia varieties gave the best results. The Red Mauritius variety of cane introduced by the State department is steadily replacing the local varieties.

The borers of sugarcane continued to be the most serious of the **pests** of this crop. Work is being continued at Pusa on these pests and other agents of damage to sugarcane crops which produce effects similar to those caused by the borers, but the magnitude of the damage done requires wholetime workers on this subject to secure proper progress.

***Cotton.*** Amongst the textile crops, cotton occupies by far the largest area in India. During the year under review, the area increased from 21,038,000 acres* in 1918 to 23,063,000. The estimated total yield was 5,845,000 bales of 400 lb. each against 3,978,000 bales* of 1918-19 or 47 per cent. higher, the acreage outturn having risen to 101 lb. from 76 lb. in 1918-19, 77 lb. being the average of the preceding ten years. The quantity of raw cotton exported during the year was 428,300 tons or 2,398,600 bales, or more than double that of the preceding year. The value of raw cotton exported was Rs. 58,65 lakhs and that of cotton goods Rs. 8,73 lakhs.

The crop is, with the exception of North-East India, one of immense importance to the country in general and has, along with wheat and rice, received a major share of the attention of the Agricultural Department.

Work has followed similar lines as with other crops, *viz.*, plant-breeding and agricultural improvement, complicated however to a much greater degree by considerations regarding the quality of the final product. Commercial and industrial considerations are thus important; the success of a selected variety often hinging on such questions as obtaining a sufficient premium for quality. In the Punjab, for example, acclimatized American types give a yield approximate to that of the *deshi*, the balance being turned in their favour by a comparatively small premium for quality. In the Central Provinces, on the other hand, owing to less favourable conditions, the

*Revised figures.

margin between short and long stapled cotton has not yet sufficiently widened to balance the difference in yield of ginned cotton which is in general much higher in the case of the short stapled *deshi* varieties.

Bombay heads the list of cotton-growing provinces, followed in order by the Central Provinces, Hyderabad State, Madras, the Punjab, the United Provinces, and the Central India States.

In the **Bombay** Presidency, a large number of exotics, selections and crosses have been tested in the principal cotton tracts.

In Gujarat, an area of 6,000 acres was last year sown with Selection IA and the produce was auctioned under departmental arrangements at a premium of Rs. 22 to Rs. 75 per *candy* (784 lb.) above the ordinary price of Surat cotton. Over one million pounds of this seed have been distributed for sowing during the current season, an amount which will suffice for the seeding of at least 60,000 acres.

The value to the cultivator of N. R. cotton, as compared with the ordinary Khandesh mixture, is now so generally appreciated that the department has been able to turn over the bulk of the distribution work to co-operative societies and seed unions. All that it had to do during the year was to supply 132,000 lb. of seed direct to the farmers. N. R. is admittedly a short stapled cotton, and the situation cannot be considered wholly satisfactory until it is definitely proved that better quality cannot compete successfully with short staple. Efforts are therefore being made to obtain for the tract a high yielding cotton with a better staple. A strain of Commilla × Bani cross, which gave satisfactory results during the past season, is being further tested on a field scale.

Dharwar No. 1, in spite of a premium over ordinary Kumpta cotton amounting to Rs. 20 per *naga*, appears to be by no means popular amongst growers in localities where it has been tried. Sufficient seed for 30,000 acres has been distributed this year in fresh tracts. Gadag No. 1 has, on the other hand, found favour in the Dharwar-American tract and is being rapidly taken up. Last season it obtained a premium of about

Rs. 65 per acre grown. Some 10,000 acres will be sown with a pure strain this season.

In **Sind**, there is a fair demand for Punjab American 4 F which fetches Rs. 2 to Rs. 3-8-0 per maund more than the local varieties. Some 70,000 lb. of seed of this variety have been distributed. Selection amongst the local Sindi mixture has shown that N. R. cotton is the most profitable type in the mixture. This seed is, therefore, being multiplied.

In the **Central Provinces**, K 22 has proved worth propagating in the Northern Circle, as it gives a high ginning percentage equal to that of *roseum* and is much earlier than the latter variety which is unsuited to the tract. The Sindewahi cross shows promise of success in the Southern Circle, while Buri (*G. hirsutum*) has continued to prove suited to the Western Circle. This variety gave the high acreage yield of 1,129 lb. of *kapas* (unginned cotton) over 22 acres on the Akola farm. A good demand prevailed for *roseum* seed, and over three million pounds sufficient for 300,000 acres were distributed in the Western Circle.

In the rotation experiments, cotton after groundnut gave about 500 lb. of *kapas* per acre more than cotton after cotton, and the value of the rotation was widely demonstrated.

In the **Madras Presidency**, the efforts of the Agricultural Department in promoting the growth and the marketing of what is known as the Company cottons in the Tinnevelly District have been of substantial benefit to the ryots, the produce being now sold in the English market at prices that exceed Middling Americans. The Cambodia cotton grown in the Coimbatore District also appears to have a promising future before it, provided the cultivators remain alive to the necessity of maintaining the quality. The two types H 25 and N 14 were tested on the Hagari farm as regards yield. The former proved to be a far better yielder than the latter. In a comparison made at Nandyal between Company Nos. 2, 3 and 14, the yield of *kapas* and lint of No. 14 was decidedly inferior to that of the other two types, but the lint brought Rs. 70 per *candy* (500 lb.) above the market rates owing to the fineness and length of its staple. At Coimbatore, Cambodia strain No. 11

gave the highest yield, *viz.*, 2,168 lb. of *kapas* per acre, representing a profit of Rs. 469, the cost of production being only Rs. 76 per acre.

Several natural crosses of cotton are under trial.

In the **Punjab**, the American cotton crop, composed mainly of Type 4 F in the canal colonies, is reckoned to have reached an area of about 525,000 acres, but during the year under review it suffered severely owing to the extreme dryness of the season in August and September 1919. No. 285 F gave a distinctly higher yield than 4 F. It possesses a longer and finer staple, and appears to be more drought-resisting than 4 F. Over 150 acres of this type are being grown by selected zemindars this year.

Amongst selections from *deshi* varieties, Mollisoni No. 24 and *G. Sanguineum* No. 28 are reported to have done well.

Several of the American selections, 168 F, 281 F, 237 F and cross $\frac{A\,1}{5}$ were valued from Rs. 625 to Rs. 650 per *candy* (784 lb.) and were better reported on than 4 F, the leading type.

Indications again point to one or at most two waterings before mid-July being ample. The beneficial effect of harrowing the crop when young is confirmed and the practice is steadily gaining ground. The area sown in lines and intercultured is increasing rapidly, marking a notable advance on previous practices.

In the **United Provinces**, the pure race CA 9, isolated from Cawnpore-American, has continued to yield well, and the work has now become largely one of multiplication of seed and distribution. At the Imperial Mills, Blackburn, this cotton spun 28's and 30's ring twist. The report states that "the cotton was found to spin fairly well and the strength was not much different from that of good $1\frac{1}{8}''$ Texas. The yarn was not quite so clean as that spun from the usual quality of Texas good middling cotton, but altogether we should consider that there should be a fair demand for this type of cotton." The ordinary Cawnpore-American, which covered 8,100 acres during the year, is now being steadily replaced by the selected

strain of which seed for some 2,000 acres has been distributed for the *kharif* of 1920. Amongst *deshi* cottons, J N 1, the pure line selection from the Bundelkhand cottons, yielded an average of 960 lb. (several fields yielding 1,200 lb.) *kapas* and 345 lb. cleaned cotton per acre, and gave satisfactory results on other farms also. This type has been found to yield its best in wet years. There is an almost unlimited demand for it from the Indian mills, but the uncertain nature of the canal supplies for the early *kharif* season imposes a severe limitation on the development of cotton growing in Bundelkhand. Seed for some 1,000 acres has, however, been distributed this year. Further district trials with K 22 were carried out. Some quite good results were obtained by individual cultivators in Hardoi and Unao, but on the whole the results were somewhat unfavourable as this cotton does not stand prolonged rain and is late in maturing. It did not do well in the Western Circle.

A detailed survey of the cottons of the province has been initiated with a view to selection of promising varieties. Some promising selections of the Perso-American type are being separated out into pure lines. Hybridization work is also in progress.

In **Burma**, the Agricultural Department is continuing the experimental work on cotton. Efforts are being made to encourage the cultivation of the pure strains of the white-flowered Wagale which gives an average ginning percentage of 38·9 as against 33 of the ordinary variety, and which is estimated to bring in a profit of at least Rs. 7 per 100 *viss*. With a view to keep the seed pure, a small ginnery has been erected by the department at Mahlaing where a co-operative ginnery also has recently been started. The value of one of the pure strains known as Pwinbyu is now widely recognized, and it should have a future in Meiktila and neighbouring districts. The average yield of selected strain No. 2108, over a period of four years, was 944 lb. per acre, an increase of more than one-third over local mixed varieties, with a considerably higher ginning percentage. The work on the crosses between Shan and Wagale, Broach and Wagyi, and Wagyi and Wagale continued to yield encouraging results. Some of these gave staples ranging from 6/8 inch to 1 inch. Of the exotics, Cambodia

again did well on the Allanmyo farm as well as on outside fields. The crop grown during the year was sold at a good premium over the local varieties. An attempt is, therefore, being made to increase the area under this variety by encouraging enterprising cultivators to take loans under the Land Improvement Loans Act for opening up new ground for it. In Shwebo District excellent results were also obtained, yields running up to 1,080 lb. *kapas* per acre.

In **Bengal**, experiments with cotton are in progress at the four principal farms of the presidency with a view to a thorough investigation of this long standing problem. The results generally, with a possible exception of Rajshahi, are not encouraging and are not likely to be so.

In **Bihar and Orissa**, work on improving the quantity and quality of lint, by selection, is in progress. A few strains of both American and *deshi* cottons, selected on the Ranchi farm, gave a high percentage of lint of fair length. These are being tested and multiplied on a larger scale. A preliminary survey was made of the existing varieties of cotton in the Santal Parganas, and samples were sent to Messrs. Tata & Sons, Bombay, for valuation. Buri, the acclimatized variety of the Santal Parganas, was reported to be the best of the local varieties. Large quantities of seed of this cotton have accordingly been distributed free to the tenants of certain Khas Mahal estates of Dumka, Pakur and Rajmahal Sub-divisions.

In the **North-West Frontier Province**, trials with the American varieties known as Mexican Big Boll, Webber No. 49 and Hartsville No. 11 proved the Mexican Big Boll to be the earliest and the best cotton in all-round merit. It is a high grade cotton having a staple fully one inch long and 32·5 per cent. lint. It is being propagated for a more extensive trial. Punjab 4 F is apparently unsuited to the climate. It grows well and bolls well but fails to mature. The variety is probably too late for the North-West Frontier Province.

In **Mysore**, the cotton selections isolated by the botanist are still under trial on a large scale. If they do as well as anticipated, a large amount of seed will be available for distribution during the following year.

The results obtained in the Central Provinces in endeavouring to control cotton **wilt disease** in soil by chemical or heat treatment have shown that such treatment is unlikely to be applicable even on a small scale. Apparently the problem is one for the plant-breeder.

Cotton is very susceptible to **insect pests**, and the question of determining the relative immunity of varieties to the pests is being studied at Pusa. A survey of alternative foodplants of bollworms, the most serious of the pests, is in progress, and the effect of parasites is being studied.

With a view to minimize the damage to Cambodia cotton crops caused by the stem weevil and the pink bollworm, the Agricultural Pests and Diseases Act was brought into force in certain parts of the Madras Presidency, and all the old crops of Cambodia cotton were uprooted by the end of August 1919. The measure has fully justified itself in the current year's crop which has been remarkably free from damage by the bollworm.

***Jute.*** The area under jute rose from 2,500,000 acres* in 1918 to 2,839,000 acres in 1919, and the total yield from 6,956,000 bales* to 8,482,000 bales of 400 lb. each, an increase of 22 per cent. The estimated outturn per acre increased by 82 lb. The value of raw and manufactured jute exported during the year was Rs. 74,72 lakhs as against Rs. 65,37 lakhs in the preceding year.

At present the world's supply of jute fibre is obtained almost entirely from North-East India. Two main species of jute are cultivated, *viz.*, *Corchorus capsularis* and *C. olitorius*, but it is from the former that the great bulk of the crop is derived. There are numerous varieties of both species, and one of the most successful pieces of work of the **Bengal** Agricultural Department has consisted in the isolation of superior yielding strains from the common mixtures found in the field.

During the year under review, there were about 135,000 acres of the pure line selection Kakya Bombai belonging to the *capsularis* species under cultivation in Eastern Bengal alone, and probably nearly 200,000 acres in the whole province. A marked tendency towards chlorosis of the leaf of most of the

*Revised figures.

*capsularis* species was noticed in the year 1917, and the isolation of non-chlorotic races accordingly became a feature of the work on jute varieties in Eastern Bengal. Almost immediate success was attained, and last year the department was in a position to issue 18 tons seed of a non-chlorotic strain of the Kakya Bombai type to growers. Tests have shown that freedom from chlorotic tendencies adds, on an average, about 160 lb. per acre to the crop. Curiously enough, the *C. olitorius* varieties do not appear to suffer from chlorosis.

Comparative tests between the two pure-line strains of *C. olitorius*, *viz.*, R 26 and Chinsura Green, showed that, on the average, the yield of Chinsura Green was nearly 5 maunds (400 lb.) per acre better than that of R 26 which had previously stood at the head of all the varieties tested as regards yield. In this case, the higher yielding power does not lie so much in its relative height as in its higher percentage of fibre. It is obvious that the department has at last discovered an *olitorius* race with outstanding capacity for yield.

One of the chief difficulties lies in seed production which is usually not profitable in Bengal as it pays the ryot better to cut the crop for fibre, and in the past arrangements had to be made to get the Government seed grown in Bihar. Owing to the increased profits to be obtained from sugarcane cultivation, however, the jute seed crop has met with a serious rival, and there has been a marked falling off in the area grown in that province. A new field for seed growing seems to be opening up in Madras where over three tons of good quality seed of R 26 were produced last season. The question of multiplication of the new strains is, however, still unsolved.

An investigation into the manurial requirements of jute has shown that the presence of sufficient potash and lime in the soil is of vital importance. Incidentally the work has yielded valuable information regarding the possibility of improving the acid red soils of East Bengal.

A bacteriological investigation into the retting process in jute and other similar fibres is in progress. The organisms concerned apparently belong to the carbohydrate decomposers and present the usual difficulties in regard to pure-culture. Their activity is much encouraged by the addition of small quantities

of salts of ammonium and phosphoric acid to the retting water. The organisms causing "heart damage" are cellulose destroyers whose optimum temperature appears to be about 104° F. Their general characteristics are being further studied.

In **Assam**, the Bengal selection Kakya Bombai has again shown its superiority over the local varieties, and is rapidly becoming popular in the jute tracts in Sylhet, Goalpara, Kamrup and Nowgong where it gave, on field trials, increased outturns of 121 to 495 lb., 405 lb., 376 lb., and 378 lb. per acre, respectively. To meet the growing demand for its seed, arrangements have been made for a larger supply from the Angarakhata fibre estate in Kamrup. The use of bone-meal and water hyacinth ash as manures on jute has proved highly profitable.

The results of experiments with jute in **Burma** carried on during the last three years tend to indicate that it can be grown successfully on waste land in Lower Burma, and that the quality of the fibre grown on such land is equal to or even superior to Bengal jute.

Of the **diseases** affecting the jute crop in Eastern Bengal, Bihar and Assam, the most important one is that known as the "black band" disease.* As its name implies, the chief symptom of the disease is the appearance of a black band round the stem of the plant. When attacked by it, the plant soon dries up and is left standing as a black stick. The results of the investigations indicate that the disease does not attack a late sown crop, and that, therefore, the earlier the seed is sown, the more liable is the resulting crop to an attack of the disease. In general, it is the well-grown stems, which result from early sowing on good soil, which are liable to this disease.

It is satisfactory to note that there is practically no danger of damage from the disease to crops intended for fibre production, and also that, by sowing late, a perfectly healthy seed crop may easily be raised. The experiments so far carried out indicate the possibility of the disease having some association with chemical conditions in the soil, but a good deal of further work is necessary to arrive at a definite conclusion on the point. It

*This is a fungus disease caused by *Diplodia Corchori*.

has been proved that steeping the seed in copper sulphate has no influence on the severity of the disease, and the practice has therefore been discontinued.

***Flax.*** Exhaustive experiments carried out at Dooriah in Bihar, between the years 1907 and 1913, showed that flax can be profitably cultivated as a cold weather crop in Bihar without irrigation. Later experiments in Northern Bengal and Assam have given similar indications. Trials of the crop under irrigation, at Cawnpore, have given yields of fibre more nearly approaching those obtained in Europe than any yet obtained in India.

During the war the general flax position became acute. Belgium and Northern France were the first of the flax-producing countries to suffer. Afterwards Russia, which before the war supplied about 80 per cent. of the world's flax, went entirely out of the market and has remained out of it ever since. Great efforts were made in Britain during the war to grow more flax and these have been successful up to a point. But in spite of this and of the fact that jute was used to a considerable extent as a substitute for flax in canvas, the price of the latter to-day is phenomenal, being roughly ten times what it was before the war.

Notwithstanding the exorbitant cost of the seed, the profits to be obtained from flax cultivation at the present time are very high. The Cawnpore results have been demonstrated to such good purpose that cultivators in the neighbourhood of the Government farm are now quite willing to grow the crop, and about two tons of seed is being distributed in the present season. Cultivators in Northern Bengal, where the conditions are highly suitable for flax, would also grow the crop if there were a good market for the straw, but the extraction of the fibre from the straw presents the real difficulty. If really good quality is aimed at, fibre extraction is a more delicate and elaborate operation than the Indian cultivator is used to. Moreover, it ordinarily involves a capital outlay in machinery which he could not afford. Capital in some form or other thus seems to be required if this opportunity of establishing a profitable flax-growing industry is to be taken advantage of.

It is not to be expected, however, that the price of flax will always remain as high as it is at present. Even if Russian supplies are not available, Canada, the United States and East Africa are all now producing flax on an increasing scale. Nevertheless, experimental evidence shows that good crops of flax can also be produced in India, and there is little doubt that they can still be handled more cheaply here than elsewhere. On the whole, therefore, there would seem to be justification for the belief that flax holds considerable possibilities of profit for the Indian cultivator, provided the problem of extracting the fibre can be satisfactorily surmounted.

***Sann-hemp*** is a particularly valuable crop to the cultivator, not only because it gives a profitable yield of fibre but also because it is a legume which forms a useful rotation to cereal and other crops. It is widely recognized as a valuable green manure and its use as such is increasing in India. The crops raised for manurial purposes are, however, usually ploughed in, and the cultivator therefore loses the price which the fibre would fetch, if sold. An artificial extraction process for the fibre would, however, still leave the major portion of the crop to be disposed of as a green manure. Fibre has now been produced artificially without the aid of the usual retting process and has been very favourably reported on by large European buyers of hemp. The remaining part of the problem is to so order the process of extraction as to enable it to constitute an economic proposition. A successful process of this nature has possibilities of far-reaching consequences in a country like India where organic matter may be regarded as generally deficient in the soil. It would also enable the cultivators in those parts of the country, for instance, the Central Provinces, the United Provinces and the Punjab, where there is often a shortage of retting water, to obtain hemp free from dirt, and thus satisfy the requirements of foreign buyers and secure a better price for the produce.

***Sida rhombifolia.*** This plant has received a considerable amount of study at Dacca, partly because of its fibre which, while of the jute class, has characteristics which give it a special value, and which would enable it to command a higher price than jute. A second reason is that, unlike jute, it need not

necessarily be sown on pre-monsoon showers. The crop opens up the possibility of producing a fine fibre of the jute class in tracts where jute itself cannot be grown.

The first experimental trials outside Bengal were conducted at Nagpur but have not so far been as successful as was anticipated. They are being repeated and other tests are being made at Cawnpore.

***Sisal-hemp.*** The comparison of sisal-hemp from various sources, in regard to the age at which the plant "poles," is in progress, the object being to find a basis for selection for the production of a more efficient plant than is available at present.

The equatorial climate and good soil of East Africa are, on the whole, more favourable to the exploitation of sisal than the corresponding conditions in India. The favourable prices for sisal, have, however, enabled one or two Indian sisal estates to do well, and there is possibility of extension on lands which are unsuited for more profitable cultivation.

***Palm fibres.*** Investigations of various palm fibres with reference to their possibilities for brush-making purposes and as cordage fibres are in progress.

***Indigo.*** The area under this crop fell from 297,000 acres in 1918-19 to 234,000 acres in 1919-20 and the estimated total yield of dye from 44,000 cwt. to 37,000 cwt. The quantity exported (32,700 cwt.) was almost the same as in the preceding year, while the value of the exports showed an increase of 6 per cent. The season was generally favourable except in parts of the Madras Presidency, the average yield of dye obtained per acre showing a slight increase over the figure for last year.

Bihar has of recent years had to depend largely for its supply of indigo seed on other provinces in India—notably the United Provinces and Assam. In the latter province, unusually fine seed crops were grown with yields of from 800 to 1,200 lb. per acre. Up to the present, wherever indigo has been grown in Assam (Jorhat, Doom-Dooma, Panchnoi), it has given extraordinary yields of green plant and seed per acre, and the quality of the plant has been unusually high. Analyses made of fresh leaf at Panchnoi last season on two different

fields gave 0·7 and 0·87 per cent. of indigotin in the leaf, and the plant contained 60 per cent. of leaf, while in Bihar the leaf contains 0·5 to 0·6 per cent. of indigotin and the plant only about 40 per cent. on the total weight.

At the present rate of yield in manufacture, the prospects for indigo would therefore appear to be favourable in Assam, where the area under tea is about to suffer a reduction on account of the reduced demand from Russia and other European countries.

Two important publications on indigo have appeared during the year, *viz.*, *Indigo Publication No.* 7 of the Agricultural Research Institute, Pusa, and *Memoir of the Imperial Department of Agriculture, Botanical Series*, Vol. XI, No. 1, the former dealing with conditions affecting quality of the indigo plant and the latter with those inducing indigo wilt.

Some light has been thrown on the subject of high quality of indigo when grown with wheat. This is apparently due to the removal of nitrates by the latter crop and the consequent stimulation of nodular growth on the indigo roots which, in turn, appears to be connected with indican formation. Other work by the Indigo Research Chemist has established the value of green-manuring to the succeeding indigo crop, rather upsetting previous ideas on the subject and suggesting new methods for the cultivation of leguminous crops in India.

Details of an improved method of growing seed, which has been successfully adopted on several of the indigo estates in Bihar, are mentioned in the Memoir. By selection work, which has been in progress for some years past, endeavours are being made to bring the crop back to a type which will thrive on the soil conditions of Bihar, giving good yields of both seed and leaf and showing a high power of resistance to wilt. Some success has already been attained in this direction.

During the year, an organization, styled the Indian Indigo Co-operative Association, has been established in Calcutta by some of those concerned in the indigo industry of Bengal and Bihar, in order to promote by co-operative methods the sale of indigo and to assist further research and propaganda.

***Tobacco.*** The most important tobacco tracts in British India lie in the provinces of Madras, Bengal, Bihar and Orissa, Bombay and Burma.

Work on the crop at Pusa was restricted to the growing of Mrs. Howard's selected types for the maintenance of pure seed. Of these, 51 were *Nicotiana tabacum* and 20 *Nicotiana rustica.* Besides these, the selected type No. 28, which combines yield and quality and is suitable both for cigarette making and for general cultivation, was grown for seed multiplication in order to obtain a large supply to meet the ever increasing demand for this type. Over 1,200 lb. of seed, sufficient to grow about 95,000 acres, were obtained. During the year, about 160 lb. of seed, sufficient for about 12,000 acres, were sent out. The largest demands were from the Indian Leaf Tobacco Development Company, Dalsing Sarai, and from Burma.

In Bengal, experimental work on tobacco was continued on the Burirhat farm in Rangpur District. The improvements effected on the Sumatra variety rendered it popular among the cultivators, and the area rose to 100 acres in the year under review as against 20 acres in the preceding year. The leaf produced at Burirhat farm fetches high prices as wrapper leaf, the preparation of which entails not only careful cultivation but also careful curing. A special officer was appointed to assist cultivators in carrying out the fermentation and curing processes recommended by the department. A co-operative sale society has now been organized among the growers of this variety of tobacco in order to enable them to procure the best market for their produce.

In Burma, the problem relating to improvement of tobacco is primarily one of curing. There the process is carried on during the early rains when the damp tends to spoil the quality. The varieties grown are, in other respects, quite suitable for cigarette and pipe tobaccos. The problem cannot, therefore, be dealt with properly until a tobacco-curing expert is appointed to the province. It is, however, intended to try at Tatkon an experiment of planting tobacco in the rains to permit of curing when the weather is dry.

***Oil-Seeds.*** The area under the various oil-seeds—linseed, rape, mustard, sesamum and groundnut—rose from 11,873,000 acres* in 1918-19 to 14,846,000 acres in 1919-20, and the yield from 1,907,000 tons* to 2,965,000 tons. The total quantity of oil-seeds exported during the year was 825,000 tons valued at Rs. 26,27 lakhs. In addition to this, the exports of *copra* (dried kernel of coconut) amounted to 10,600 tons as against 450 tons in 1918-19.

India is one of the largest of the world's sources of supply of oil-seeds. The output of the raw product has been recently far short of the world's demands, and the prevailing high prices are acting as an incentive to increased production of various kinds of oil-seeds.

*Groundnut.* The area under this crop rose from 1,407,000 acres in 1918-19 to 1,570,000 acres in 1919-20, and the yield from 626,000 tons to 884,000 tons. On account of its great intrinsic value and the fact that it grows well even on poor land with the cheapest of manuring, an expansion of area is being pushed in all provinces. Selection work and varietal tests are in progress.

In Bihar and Orissa, the work on this crop is being carried on at Ranchi. The upright varieties selected there have been sent out for trial at lower elevations. The crop is fast extending in Orissa. It has been successfully introduced on sandy land in Gaya District, where the yield on areas treated with ashes amounted to 1,804 lb. against 902 lb. per acre from the untreated areas.

In Madras, in the varietal tests in the well-irrigated dry area, local Mauritius yielded the best, Big Japanese and Carolina ranking second and third respectively.

In Burma, experiments were continued in several districts with satisfactory results. In yield and oil content, Pondicherry, Small Japanese and Spanish varieties again maintained their superiority over the local Shan nut. A great demand for the Spanish nut has sprung up in Meiktila District. An outstanding feature of this variety is that it is less susceptible than other varieties to the effects of unfavourable rainfall.

*Revised figures.

*Sesamum.* After a series of variety tests, four types of sesamum have been selected in Burma for propagation. In the case of branched types, drilling has been found preferable to broadcasting. A simple type of drill, designed for the purpose, is giving very satisfactory results. The planting of early sesamum before irrigated paddy has met with considerable success in the Mon canal area of Minbu.

*Coconuts.* In Madras, considerable progress was made in the study of coconut palm during the year under report. The results so far attained point to the necessity of a more thorough study of the root system of this tree, which is expected to throw light on the causes of the great variation between the yields of different trees grown under apparently identical conditions. The possibilities of the coconut as a sugar producer also requires a careful investigation, and this aspect will, it is hoped, be taken up in the near future.

Comparative experiments have been started at Cuttack with several varieties of coconuts from Malabar and with seed obtained locally at Balasore, with a view to finding out the best varieties and the most suitable methods of cultivation and manuring for the Orissa deltas. There appears to be almost unlimited possibilities of development of coconut cultivation in this tract if drainge can be secured.

The programme of the Burma Department of Agriculture includes experiments on a considerable scale in the cultivation of this important crop, and a start has been made with a plantation at Hmawbi.

In the Travancore State, investigations on the crop showed the nuts harvested in February and March to be of better quality than those harvested at other times. Variety trials and cultural and manurial experiments also are in progress there.

A disease of coconuts known as the "bleeding disease" has been cured by operation in South Kanara and North Malabar Districts in the Madras Presidency. The treatment was given in the presence of garden owners who were familiarized with the instruments.

The most important pest of coconut dealt with by the Travancore Department of Agriculture was *Nephantis serinopa*

which appeared in several places in Central Travancore. The only successful remedy is to cut off and burn the attacked leaves. Over 7,000 trees were treated in this way.

***Tea.*** The total area under tea was reported to be 691,800 acres, which is 2 per cent. higher than that of the preceding year. The total production of manufactured tea (black and green) was reported to be 377,028,500 lb. as against 380,459,000 lb. in the previous year. The quantity of tea exported during the year was 379 million pounds and surpassed all previous records. The total value of the exports was Rs. 20,56 lakhs.

The outlook for the new season, however, is distinctly gloomy. The home market is glutted with tea, and prices have fallen until the producer's margin of profit has in many cases disappeared. Apparently, the present conditions have resulted entirely from the disorganization of international trade caused by the war. In 1913, Russia alone took 191,000,000 lb. of tea, and if she, along with other continental countries, could resume her pre-war consumption, no surplus stocks would exist, but the prospects of such a contingency seem to be remote. With a view to meet the present situation, the Indian Tea Association have decided to restrict production this year by 10 per cent. below the 1915-19 average and next year by 20 per cent.

As in previous years, the Indian Tea Association continued to maintain a scientific department for the investigation of all problems connected with tea, with the help of the usual grant-in-aid from Government. A great deal of useful work has been done by the Association's scientific department and the results have been duly published. The inoculation of tea bushes affected with mosquito blight (*Helopeltis thievora*) by potash salts is a piece of work of outstanding value. Bushes which had apparently succumbed entirely to the attacks of the pest were cured through inoculation and gave vigorous flushes, although the surrounding untreated bushes remained in a moribund state.

In Southern India, the crop continued to receive special attention from the Deputy Director of Agriculture for Planting Districts. The root diseases of tea are of primary importance,

and a great deal of work was done on these during the year. The use of green dressings on tea estates and of cover crops of all kinds to prevent soil erosion are also items of considerable importance in Southern India.

***Coffee.*** There are about 223,000 acres of coffee under cultivation in South India, about 74 per cent. of which are in Mysore and Coorg where the plantations are mainly in the hands of Indians. During the year crops have been good and prices phenomenally high. The work in Coorg with coffee hybrids has proceeded satisfactorily. The new hybrid referred to in last year's report gave its virgin crop, which averaged about 8 cwt. per acre. Another hybrid of good promise is also receiving attention. Seed of both these types is now on the market and is in great demand. It is expected that, in a few years' time, the new types will produce a marked improvement on the yield of estates. Manuring problems are receiving attention. In Mysore, experiments on the treatment of coffee on estates affected by the coffee borer are in progress.

***Rubber.*** A great deal of work has been done on rubber during the year and a number of experiments are being conducted on South India estates. The most important of these are: (*a*) the study of manurial systems (lime, green dressings, phosphates) at Wandur and Pudukad, (*b*) the study of green dressings, for both old and young rubber, at Pudukad, (*c*) a series of manurial experiments at Kerala, (*d*) a spacing experiment at Kerala, and (*e*) the control of *Phytophthora Meadii*, a serious disease of rubber, by the removal of the fruits and dead branches, at Pullengode. The study of a mysterious disease known as "brown bast," the incidence of which is as high as 40 per cent. of trees on some estates, occupied a prominent position in the year's programme. A number of experiments designed to control the disease have been tried without attaining any considerable success.

On account of a glut in the market for rubber, the Rubber Growers' Association have recently recommended a reduction of output by 25 per cent.

***Fruit.*** There exists a very general opinion that India with its varying altitudes and climates ought to occupy a more pro-

minent position as a fruit growing country through the improvement and extension of the great variety of fruits to be found inside her borders. The workers hitherto employed have been too few and too scattered to permit of any considerable advance, but the results of work done have almost invariably shown the great possibilities of improvement in fruit through careful selection of trees and tillage of the soil. At Quetta, for example, the problem has been put on a satisfactory footing, and in several of the provinces earnest efforts are now being made to popularize the better varieties of fruits, improved methods of cultivation, packing, etc. As a result of these efforts, a number of really good gardens laid out and worked on scientific lines are to be seen in various parts of the country. A more thorough investigation of the economics of fruit growing is, however, necessary. The problem has now to be viewed from a wider angle and the possibility of establishing a system of co-operative marketing, such as that employed by the fruit growers in California, has to be tested. It is already a paying industry and ought to have a prosperous future before it. Further, fruit growing can employ and ought to attract a large number of the educated classes who are unsuited to other classes of farming.

Much valuable work on fruit crops lies to the credit of the Bombay Department of Agriculture. A thorough investigation has been made into the various methods of propagating the mango and the best conditions for propagation. Enarching has been found to be the most suited to dry conditions, while, for moist conditions, whip-grafting has given excellent results. For the renovation of old and useless trees, top-working has proved to be the most beneficial method. The question of the best stock on which to bud the several species of oranges and limes has been exhaustively studied, the Jamburi, a sour lime, being found to be the most suitable stock. A nearly seedless guava has been discovered in Sind and the variety is being distributed. Satisfactory systems of pruning guavas and figs have been worked out, and several improvements have been introduced in the local systems of training the vine plants, leading to largely increased yields. On several of the Government farms small fruit gardens have been established, and, from these, nursery

stock of the kinds of trees suited to local conditions are distributed.

The work has also made good progress at Peshawar and Haripur in the North-West Frontier Province. Among the new fruits which have proved suitable for the Indian market may be mentioned the Gonzales, Wickson, Ogon, Rubio and Federation plums, the Le Conte and Kieffer pears, the Lisbon lemon and some of the persimmons. Thirty-five thousand budded fruit trees, hardly any one of which is less than five feet high, are ready for distribution. To establish a valuable fruit trade in the province, it now remains for the fruit growers to plant out extensive orchards on sound lines. At Shillong, excellent fruit, including numerous varieties of apples and pears, has been produced on the Government Fruit Experiment Station. Arrangements have been made to supply grafts to cultivators in the Khasi and Jaintia Hills, and six orchards on cultivators' holdings have been planted out for this purpose. Should these prove successful, there will be no difficulty in extending the fruit industry in that part of the province. In the gardens at Tissema in Naga Hills, guava, grapes, pomaloes and small Japanese oranges did well, and grafts were freely distributed to cultivators of the locality.

Diseases and pests of fruit trees were under observation by the Mycological and Entomological Sections at Pusa and by the Entomologist to the Government of the Punjab. Spraying the orchards usually gave good results, and, in general, the superiority of the fruit on the sprayed trees was very marked. At Gujranwala and Sargodha in the Punjab, spraying is rapidly gaining in popularity. The income of a garden at Sargodha is said to have been raised from Rs. 300 to Rs. 1,200 through effective spraying. Fruit growers in that locality are now purchasing complete spraying outfits.

***Fodder Crops and Grasses.*** In the greater part of India, crops grown purely for fodder are the exception and not the rule, the cultivator depending mainly on the straw of his grain crops for his cattle supplemented by a certain amount of "stubble grazing." Except indirectly through increasing straw yields, the Agricultural Department has, therefore, done

little in the direction of the study of purely fodder crops, although some of the problems connected with fodder raising and storing in famine areas have received a certain amount of attention.

The Bombay department has, for example, studied methods of fodder production, and are working at the renovation of poor pastures. The possibilities of hay-making on a large scale, methods of storing hay, storage in silos of green grass, *juar* (*A. Sorghum*), maize and sugarcane tops have been the subject of demonstration.

An important piece of work on *baisurai* (*Pluchea lanceolata*), a troublesome weed in the *rabi* crop in parts of the United Provinces, has been conducted by Dr. Parr, Deputy Director of Agriculture, Western Circle. On account of its deep rooted system, this weed competes successfully with unirrigated *rabi* crops and seriously affects their yields. The problem of its eradication or how best to utilize it is thus of considerable importance. Experiments have shown that although cattle carefully avoid it in the green state on account of its disagreeable taste, when cut and dried in the sun till the leaves are quite brittle, it becomes palatable and can with safety be fed to work bullocks up to at least 8 lb. per day mixed with 10 lb. of *bhusa*. It moreover possesses a much higher feeding value than either *bhusa* or *juar* stalks. It has been estimated that, in years of normal rainfall, over 107,000 tons of *baisurai* can be cut annually in the four districts of Aligarh, Muttra, Agra and Etah, where there is a continuous tract of land, about one million acres in area, more or less infested with the weed. With the present prices of fodder this quantity would, if utilized, be worth not less than 15 lakhs of rupees. The effect of feeding dried *baisurai* to young stock and milch cattle is being further studied.

In Burma, a number of fodder crops are under trial, the most important including *sat* (*Pennisetum typhoideum*), saccaline (*Sorghum saccharatum*), guinea grass, teosinte (*Euchlæna mexicana*) and of *uba* cane (*Saccharum* sp.).

The series of tests which have been in progress on the Tarnab farm in the North-West Frontier Province since 1911 have

shown that berseem (*Trifolium alexandrinum*) yields much more fodder per acre than shaftal (*T. resupinatum*), while the land is equally benefited by their cultivation. Either of these, if sown about the middle of September, yields five good cuttings and a crop of seed by the end of June.

In Madras, guinea grass was successfully grown at Coimbatore, Palur, Gudiyattam and Samalkota, and yielded up to 73, 124 lb. of green grass per acre. It has been much in demand at Palur and Gudiyattam because of local fodder difficulties. Teff grass, which is an emergency food and fodder crop, was successfully grown at Palur, the fodder being readily consumed by cattle, while bread and gruel prepared from the grain are said to be not unpalatable.

At Jorhat in Assam, both guinea grass and Rhodes grass cropped well. The latter, however, was found much more difficult to establish and needed more subsequent care than the former. Sudan grass from Australian seed also does fairly well.

***Miscellaneous Crops.*** **Juar** (*Sorghum*) which is of considerable importance in Bombay, Madras, the Central Provinces and the United Provinces, has, on account of shortage of staff, hitherto received comparatively little attention. In Bombay, seed obtained by mass selection is in considerable demand. Two varieties of milo (standard and dwarf) which are reported to have resisted all kinds of *juar* smuts in America are under trial. While both the varieties have been found hitherto resistant to the grain smut, the resistance does not appear to hold as regards "loose" smut. In Madras, the strains selected by the department are now being issued. During the year, 3,568 lb. of selected seed were distributed to cultivators from the Nandyal and Hagari farms. A few types of *juar* selected at the Aligarh farm in the United Provinces were under trial, two types, B1 (white) and C2 (white), being easily at the head of the list as regards grain yielding qualities. Andhari and Dodania proved to be the best types for green fodder. The variety Ramkhel continued to maintain its superiority in the Central Provinces and yielded 1,682 lb. of grain per acre over nearly seven acres on the Akola farm. The use of roller in

threshing this crop gave satisfactory results and proved considerably less expensive than the usual practice of trampling by bullocks.

**Ragi** (*Eleusine coracana*). In Madras, Hagari No. 8 *ragi* gave better yields than local varieties, wherever it was tried. Late *ragi* was found invariably to give lower yields than early *ragi*. The irrigation experiments showed that the crop required 21·94 inches of water, including a rainfall of 15·67 inches.

In Mysore, a large quantity of seed of an improved strain of *ragi* (H22) was distributed and very favourably reported upon, the average increase in yield being 30 per cent. greater than that of the local *ragi* sown alongside. The most striking features of the new variety are its freedom from shedding and sprouting in the ears under moist conditions at the time of harvest. It is considered that it will not prove a difficult matter to extend the area under this variety to 50,000 acres, representing a money return of Rs. 25 lakhs per annum, within the next five years. Some of the other selections in hand are, however, likely to turn out heavier yielders than H22. These are being tested on a number of private estates in various *ragi*-growing tracts. The very favourable results obtained by rotating *ragi* with groundnut deserve special mention. Some of the best selected strains have, after groundnut, given high yields of grain per acre. The results of manurial, cultivation and varietal experiments extending over a period of nine years have been recently published. The whole question of *ragi* cultivation has been carefully studied from all practical points of view and the results are commensurate with the thoroughness of the investigations.

**Potatoes.** Experiments with Scotch potatoes were continued in Simla where they easily beat the *deshi* varieties of potatoes in yield.

Experiments in storage are in progress at Sialkot, the centre of potato cultivation in the Punjab.

The acclimatizing, testing and distribution of potato seeds continue to be the main feature of the programme of the Upper Shillong farm in Assam. This year 23 varieties were under test. King of Potatoes, Magnum Bonum, Windsor Castle, Up-to-date and Imperator again gave the heaviest yields. There is

great demand both from the hills and the plains districts and from outside the province for the selected seeds. To assist propagation, seed potatoes are distributed free to Khasi cultivators on condition that they return one and a half times as much as the seed supplied.

Rapid strides have been made in Burma with the introduction of exotic varieties of potatoes and in improving the cultivation of the crop. It has been shown that, by a combination of ridging, manuring and liming, present outturns may be trebled. A new method of storing seed potatoes in trays with bamboo floors was tried and found to be beneficial.

The study of the *tambera* disease of potato, which had been in progress in the Bombay Presidency, has conclusively proved that the disease is caused by a mite and can be easily controlled by sulphur treatment. The study of the storage "rots" during the hot weather and rains at Pusa, Bombay and in the Punjab, indicate that the rot is primarily a result of excessive temperature, and that it will be difficult, if not impossible, to check it unless some form of cool storage can be devised. Investigations have proved that "ring disease," which is one of the greatest enemies of potato growers, is conveyed from crop to crop through the seed and the soil. The infection does not, however, live long in the soil in a virulent enough condition to affect new plants, and if land is kept free for six months from potatoes or other plants of the same order like tobacco, capable of carrying the disease, the danger of infection through the soil will be very small, if not entirely eliminated. Attention has therefore to be focussed on the provision of disease-free seed. The Bombay department has apparently succeeded in developing a pedigree strain of potato seed resistant to ring disease.

**Beans and Peas.** In Burma, the area under Pebyugale (*Phaseolus lunatus*) decreased by 200,000 acres, probably on account of the "prussic acid" scare. Definite information regarding the truth of the assertions as regards prussic acid and a study of the various types of soy beans as regards poisonous qualities are urgently required. Although work has been restricted through want of staff, some progress is recorded in the selection of new strains, and the examination of beans under

storage. Preliminary work shows that there is a tendency towards increase of prussic acid in Burma bean during storage.

Work on soy beans is in progress at Ranchi in Bihar and Orissa where they grow well and give yields up to 600 lb. per acre. Two new varieties have been obtained from America and selection is being continued.

A few strains of field peas isolated at Sabour have given promising yields and should shortly be available for distribution. The Para pea, a small seeded variety of cowpea introduced from the West Indies, was tested on the Jorhat farm in Assam, both as green crop and as a pulse.

**Gram.** Five types of Pusa selected grams were grown at the Institute area for observation and multiplication of pure seed. Some 1,200 lb. of seed of types 6, 17, 18, 23 and 25 were distributed. In Bihar, the Pusa grams again gave better yields than the local varieties. In variety tests, *deshi* Malida and Nimari grams did well on the Hoshangabad farm in the Central Provinces.

**Poppy.** In pre-war days the opium produced in the Balkans and Asia Minor, which normally contains 12 to 14 per cent. of morphine, practically held the monopoly of the medical opium market. During the war the supply of medical opium failed, and it was considered desirable to try to replace the foreign product by one produced within the Empire. Botanical and chemical investigations into the problem of raising the morphine content of Indian opium, which is normally estimated at about 8 per cent., were therefore started at Cawnpore. The results so far obtained have been satisfactory. Races of poppies have been isolated which yield opium of as high a morphine content as 20 per cent. Chemical examinations have indicated the reasons for the low morphine content of the Indian product and how to raise it. Numerous useful observations have been made, for the details of which readers interested in the subject are referred to an article by Messrs. Leake and Ram Prasad published in the *Journal of Genetics*, Vol. X, No. 1, and to that by Messrs. Leake and Annett issued in the *Agricultural Journal of India*, Vol. XV, Part II, of March 1920. During the year, an extensive distribution of seed of a robust and high morphine-yielding race was carried out in Rae Bareli.

## CHAPTER III.

## RESEARCH AND INVESTIGATION.

It is not possible to do here anything like adequate justice to the large amount of work done during the year under review, especially as most of the investigations are in progress and have not yet reached a definite stage at which the year's results could in any way be interesting to the general public. We, therefore, propose to deal briefly with the main lines of work or developments not already referred to under different crops in the preceding chapter, and to refer the readers interested in any particular branch of research to the year's Scientific Reports of the Agricultural Research Institute, Pusa, and to those of the provincial research officers, which are published separately.

### I. Soils.

***Survey of Soils.*** In *Bengal,* considerable progress has been made with the provincial soil survey. The analysis of the soils of various experimental plots was brought to a conclusion. As a development of this work, analyses of the ash of plants grown on the plots have been made. Little variation was found between different plots as regards availability of phosphates when lime was applied, but dressings of lime increased the availability of potash.

In *Bihar and Orissa,* a fresh traverse survey across the centre of South Bhagalpur and a similar traverse across the centre of the Kosi area in Purnea are almost finished. Very marked differences have been found between these two types of soils. While the former appears as a rule to be poor in phosphate, the latter is generally rich in that constituent.

In the *Central Provinces,* the survey of soils suitable or otherwise for the cultivation of *Citrus* crops has been completed. In view of the increased interest now being shown by many in the cultivation of fruit, it is expected that the results will be of considerable value.

In *Madras*, the survey of the soils of the Godavari delta indicated a deficiency of nitrogen in 40 per cent. of the samples and of phosphoric acid in about 25 per cent. Manures such as fish guano, rich both in nitrogen and phosphoric acid, should therefore give good results there. The analyses of the samples collected in the Periyar survey are also well forward but the results are found to be very variable.

Periodical determinations of carbon dioxide were made in the soil air of three plots in the Botanical Area at *Pusa*. The percentage of carbon dioxide was found to be the highest in the grassed plot, and the lowest in the cultivated plot, the air in the soil of the trenched plot being intermediate in composition. There was a sudden rise in the percentage in the months of July to September, which is possibly connected with the rainfall and with the movements of the soil water level.

***Soil bio'ogy.*** In the *Central Provinces*, a considerable amount of attention has been paid to methods which will meet the call on the fertility of the soil which high yielding varieties of crops must make. The enhancement of the recuperative power of the soil is a problem of importance. An interesting research on the relative merits of open and embanked methods of wheat cultivation is in progress.

In *Assam*, special laboratory work was undertaken on the Kamrup soil with a view to determine the influence of carbonate of lime on the biochemical processes of the soil. It was found that ammonification and nitrification were very much improved, both in respect of the soil's original and added sources of nitrogen. No nitrification, however, took place under any conditions when the percentage of soil moisture was raised to 23. As such a high percentage of soil moisture is actually found to occur on certain low-lying areas in Assam during the rains, the experiment emphasizes the great importance of good drainage. Estimations of soil nitrogen, carried out at Jorhat, point to one of the following two effects or both, *viz.*, (1) less loss of soil nitrogen from the limed plots in directions other than as crop removals, and (2) the activity in the limed soil of some nitrogen recuperative agency. The experiments also emphasize the great length of time over which an initial application of lime continues favourably to influence

cropping. In regard to the value of large *versus* small and more frequent lime dressings, the year's evidence was in favour of the latter. Other experiments continue to prove that for most farm crops it pays not to incorporate lime too deeply. The unlimed plots, though richer in available potash and phosphoric acid than the corresponding limed plots, still fail to yield a crop.

Investigations of the nitrification of cowdung, cow urine, and sheepfold manure were carried out at *Pusa*. In the case of cowdung it was found that when added to the soil in the fresh state, no nitrate accumulation took place, but when added after storing, under either aerobic or anaerobic conditions, about one-third of its nitrogen was converted into nitrate. The nitrogen of the urine was rapidly converted into nitrate in the soil. The inhibiting effect of excess of carbohydrate on nitrification was shown by the results obtained when straw was added with the dung or urine. It has been found that the loss of nitrogen in urine during storage can be avoided by storing it under anaerobic conditions which can be easily maintained by covering the urine with a very thin layer of kerosene oil.

A study of the wide variations in the accumulation of nitrate during the decomposition of various oil-cakes in Pusa soil tends to the conclusion that they are due to the differences in the relative proportions of carbohydrate and nitrogen in the cakes. The oil content had very slight influence on nitrification, but the addition of such materials as cellulose, filter paper, sawdust, starch, cane sugar and glucose to cakes rich in nitrogen, retarded the accumulation of nitrate. Further, in the case of *mahua* (*Bassia latifolia*) cake, no nitrate was found after eight weeks' incubation, except when the cake had previously been fermented.

The nitrogen content of soil under fallow and growing crops was also studied at Pusa. Both nitrate and organic nitrogen contents of the cropped plots were lower than those of fallow plots, and the differences were greatest during the period of most active growth of the crop.

***Nitrogen fixation.*** In the *Punjab*, the average nitrogen fixation has been found to be 3·5 per cent. In 1918, heavy

loam soils contained, on an average, 47 lb. of nitrogen per acre in top 9 inches, light loams 61 lb. and sandy soils 50 lb., while in 1919, the figures were 48 lb., 62 lb. and 56 lb., respectively. Thus, in 1919, the sandy soils seem to have fixed most nitrogen.

Experiments on the effect of the accumulated products of its metabolism on the nitrogen fixing power of Azotobacter are being carried out at *Pusa*. So far it appears that these products appreciably lower the amount of nitrogen fixation.

Twelve species of actinomycetes were examined for nitrogen-fixing power. Although only minute gains were recorded, still as this group of organisms is one of the most abundant in soils, the accumulated effect may be of considerable importance, and further investigations of their activities are being taken up.

Sugarcane megasse has proved an admirable medium for the growth of nitrogen-fixing organisms. After inoculation with mixed cultures of nitrogen-fixing organisms, its nitrogen content rose from 0·27 per cent. to 1·3 per cent. in two months.

***Soil moisture.*** Some interesting and important investigations in the distribution of soil moisture underneath a watercourse were carried on by Mr. Wilsdon in the Punjab. The main directions in which laboratory investigations have been pushed are (1) the study of the colloidal properties of the clay in the soils by compressibility measurements, (2) determination of the vapour pressure curve for water in soils, and (3) investigation of the effect of the osmotic pressure of the soil solution on the moisture equilibrium. The tentative conclusion is that the lining of canals will only postpone the date of waterlogging. A short account of the work is in the press as a Memoir of the Imperial Department of Agriculture in India. The Drainage Board is arranging for a practical test, never hitherto applied under satisfactory conditions and on a sufficiently long channel, of the actual effect of lining.

***Sullage investigations*** were continued in the Punjab, but it is as yet too early to draw any conclusion from the results so far obtained. Mr. Wilsdon, however, remarks that the worst results were in all cases obtained by the use of the most concentrated sullage.

## II. Fertilizers.

The permanent manurial and rotational experiments started on the *Pusa* farm in 1908, with the object of determining the specific effect on soil fertility of the more common organic and chemical manures applied alone and in various combinations to a 2-year 4-course rotation, were continued. Some useful results have been obtained but they require to be tested more rigorously.

The investigations in regard to the retention of phosphoric acid in calcareous and non-calcareous soils, in progress at Pusa, has reached a stage which has enabled the Imperial Agricultural Chemist to submit them for publication. The results indicate that the phosphate manuring of calcareous soils is a very different problem to that of non-calcareous soils, and requires special study.

A series of experiments with local paddy were carried out at Pusa to compare the effect of ammonium sulphate, used alone and in combination with green manures. It was found that small doses of nitrogen increased the proportion of straw to that of grain, but with 80—160 lb. to the acre the increase in grain was greater than that of straw. The employment of ammonium sulphate as a manure resulted in a considerable increase in the percentage of nitrogen found in the grain, and the increase was approximately proportional to the amount of nitrogen added as manure. This very interesting point is being subjected to further investigation.

An investigation of the methods of analysis of nitrogen and phosphoric acid in manures and fertilizers is in progress at Pusa.

In *Bihar and Orissa,* field experiments initiated with a view to test the effect of phosphates, with and without green manure (*Sesbania*), on paddy, in a certain tract of South Bhagalpur the soil of which is poor in phosphate constituent, gave very remarkable results. Phosphates produced a small increase of paddy, both by themselves and when applied at the time of puddling in the green manure. But this small increase was turned into an increase of about 45 per cent. when either acid or basic superphosphate was applied at the rate of 240 lb. per acre at the time of sowing *S. aculeata.*

In *Madras*, the art of manuring paddy is being studied in several series of carefully designed experiments. Contrary to what is generally supposed, one of the plots grown with green manure yielded better than the corresponding crop to which green manure was brought in from outside. Both bone-meal and Trichinopoly phosphate indicated a considerable effect in the first year of application, although not as marked as that of superphosphate, but there was very little difference in yield in the second year. The results of the experiments designed to test the availability of phosphate by itself, *i.e.*, without leaf manure, to paddy soils, were equally interesting: when superphosphate was applied at 350 lb. per acre, there was, after four years of application, a residual value of manure equal to 240 lb. of crop per acre. In an experiment with increasing quantities of soluble phosphate applied for four years in succession, the best results were obtained from 100 lb. of manure per acre. From another series is drawn the inference that the less concentrated manures like basic super and basic phosphate show more manurial residues than the corresponding concentrated manures. Experiments on composting with mineral phosphates and green manures showed that the compost gave an increased yield of paddy in every case of application.

### III. Windrowing of Sugarcane.

An account of the work done at Peshawar on the windrowing of sugarcane is under publication. Further work on the subject has shown that canes are capable of being windrowed at Pusa inspite of the fact that the temperature conditions are much higher than those obtaining at Peshawar.

Work on the changes taking place in different parts of the cane stem was continued by Mr. Meggitt in Assam. The enquiry is not yet complete.

### IV. Prussic Acid in Juar.

The conditions which favour the formation of prussic acid in *juar* (*Andropogon Sorghum*) were studied in the laboratory of the Agricultural Chemist, Bihar and Orissa. The records of an interesting series of observations indicate that (1) the humidity of the atmosphere has a much greater effect than soil

moisture upon the formation of this acid, (2) dried *juar* kept for some time, and also dying plants, show no trace of prussic acid, and (3) plants grown in the shade contain a slightly higher percentage of acid than those grown in the sun.

## V. Diseases of Crops.

Some indications of the year's results on investigations relating to the diseases of crops such as rice, cotton, jute, indigo, coconut, tea, rubber, fruits and potato have already been given under the respective crops in the last chapter, and it is therefore proposed to indicate briefly below the other items of work in progress.

It has long been apparent to mycologists in India that there is a large group of parasites belonging to *Fusarium*, *Helminthosporium* and allied genera which attack cereals throughout the country. The study of the species allied to *Helminthosporium* has been taken up at Pusa and is likely to extend over several years.

Species of *Helminthosporium* were found commonly attacking maize, *juar*, *bajra* (*P. typhoideum*), rice, wheat, oats, barley, and sugarcane. In every case the chief attack is on the leaves, and, excepting the stripe disease of barley, the symptoms are on the whole very similar. The parasite concerned was isolated from each of the above hosts and grown in pure culture for comparative study. The species on sugarcane and rice attack all the hosts on which they have been tried, whereas the wheat and barley species give reciprocal successful results. Further work on these lines is being done.

An allied genus, *Acrothecium*, is parasitic on several of the *Gramineæ*, and one species attacks *bajra* at Pusa somewhat severely. It is a new species, which has been named *Acrothecium Penniseti*. The parasite has been isolated and studied in artificial culture. A detailed account of the work is now in the press as a Memoir. It is a vigorous parasite, with general points of similarity to other parasities of allied genera. It can attack maize ears but not the leaves; *juar* is immune.

A second species, *Acrothecium lunatum* Wakker, is common at Pusa on maize and *juar*, as well as on several wild grasses. It appears to do a good deal of injury to the male inflorescence

of the former, where it is sometimes associated with *Acrothecium falcatum* Tehon, but it is only a weak parasite on *juar*. It is capable of attacking young leaves of *bajra* to some extent. Another form is found on rice. All these are being studied in pure culture.

During the past year, a number of reports and specimens of disease in wheat with the general symptoms of the foot rot disease, which has attracted so much attention in the United States in recent years, were received in Pusa. As in the United States, a group of fungi appears to be responsible for the disease. In India the most destructive is a species of *Fusarium*; all the fungi are being studied.

The palm disease operations in the Godavari and Kistna Districts in Madras have for a long time claimed a leading share in the attention of the provincial Mycologist. The very careful manner in which remedial measures were applied to the disease reflects credit on his section.

## VI. Insect Pests.

The results of inquiries relating to the important pests of rice, sugarcane and cotton have been referred to elsewhere and need no recapitulation. The extent of damage done annually by these and other crop pests is so great that it necessitates devotion of serious attention to remedial measures, but shortage of staff has continued to retard progress here as in other branches of the department's activities. Nevertheless, the small staff of entomologists has successfully recorded a very large amount of useful observations relating to the life-histories and behaviour of most of the insects known to afflict crops and of their parasites, and has thus advanced a step further towards working out scientific methods for control of pests. Some items of investigation carried out by the Entomological Section at *Pusa* and by provincial workers on the subject are briefly indicated below :—

Frequent reports have been received from Bengal regarding the damage done to mulberry by *Phenacoccus hirsutus*, the mealy-bug scale-insect which is the cause of *Tukra*. Collection of alternative foodplants showed that this scale was very common at Pusa on cotton and guava. Effects of the predators

that keep this mealy-bug in check to some extent are under study.

Considerable material has been accumulated regarding various insect pests of fruit trees, and the pests are under investigation.

The results of the long series of experiments and the details of the successful method of storage under sand evolved therefrom for the storage of grains have been fully described in a paper, by Messrs. T. Bainbrigge Fletcher and C. C. Ghosh, recently published. Further work was continued during the year, especially with a view to finding out whether there is any infestation in the fields and, if so, to what extent.

The Board of Agriculture, at their meeting in December 1919, recommended that the problems of grain storage, with special reference to the question of damage by insect pests, should be taken up on a large scale, and that the staff of the Imperial Entomologist should be increased for this purpose. Proposals for an increased staff for the work are under consideration.

During the year the Punjab has furnished a telling example of the seriousness of the damage due to weevils. The department stored some *juar* seed at Hoshiarpur, which was more than decimated by weevils though fumigation with such strong poisons as carbon bisulphide and hydrocyanic acid gas was resorted to, and the loss to Government amounted to no less a figure than Rs. 25,000 in connection with about 182 tons of seed.

Another serious enemy of stored grain is the rat, and it is perhaps not out of place to mention the interesting investigations on rats carried out by Major J. C. C. Kunhardt, I.M.S., late member of the Plague Research Committee. According to his estimation, the average rat consumes about 6 lb. of grain in a year, and as the rat population in India numbers about 800 millions, the food bill of these rodents is put at Rs. 15 crores per annum.

In the *Punjab*, much attention was devoted to the study of the life-history of parasites of crop-pests. Extensive experiments have been designed to check the efficacy of *Microbracon*

in fighting the bollworm of cotton. Forty-five different parasitic insects have already been bred out.

In *Bihar and Orissa,* some progress has been made with the investigation of one of the parasites of *Agrotis ypsilon* that causes periodical damage in the Tals of Mokameh. It has been found that the parasites emerge from their cocoons so long as the maximum daily temperature is below 83° and cease to emerge thereafter. Their regular emergence, however, recommences, even after several months' aestivation, on exposure for some time to artificially lowered temperatures. There is thus some prospects of controlling this parasite, and an experiment on a large scale will be attempted in the coming season.

In *Assam,* dusting with lime and powdered soil sprinkled with kerosene oil gave good results in dealing with mustard aphis and mustard sawfly in Kamrup, Sylhet and Jorhat. Mites were found to be serious in *litchi* trees on the Jorhat farm, but by a thorough pruning and destruction of the affected leaves and twigs, the trees were saved.

## VII. Useful Insects.

***Bees.*** The experiments at Pusa have disproved the idea that bee-keeping can only be followed in the hills. As a matter of fact, imported bees have, on an average, yielded about 80 lb. weight of honey per hive against 6 lb. per hive by the ordinary local bee at Pusa. It is an industry that can be carried on in most localities at small initial cost and with comparatively little trouble. On account of the low yield of honey available from the ordinary Indian bee, it appears extremely desirable to initiate experiments with crosses between the Indian honey-bee and other races from Europe, North Africa and Egypt, in order to obtain a form which will be suitable for domestication in the plains.

***Lac.*** Brood lac was sent out from Pusa to various parts of the country and the demand outstripped the supply.

During the year, several inquiries were received by the Imperial Entomologist from Bengal regarding any possible connection between the presence of lac insects and pebrine in silkworms. Specimens of lac insects, received from Malda and

Berhampore, did not reveal the presence of any pebrine bodies in the female insects, and it is not considered likely that lac insects will be found to be affected by pebrine but experiments on this line are being started. In this connection it may be noted that both lac and silkworms have been cultivated successfully at Pusa for more than ten years, which seems to dispose of the superstition current in the silkworm rearing districts of Bengal that cocoon crops cannot be successful if lac and silkworms be grown in the same place. The price of lac has advanced so much recently, having gone up to practically ten times the pre-war rates, that the question of lac-production in India has become one of no small economic importance.

***Silkworms.*** While the importance of organizing and improving the silk industry in India is fully realized, no great progress can be made till the question of provision of disease-free seed has been solved, and with this end in view, a Protozoologist has been appointed at *Pusa* to undertake the necessary research work. Steps are now being taken to establish under his control an experimental seed station. Meanwhile, he has taken up the investigation of the life-history of the parasite *Nosema bombycis*, which causes the disease known as pebrine, and of means of controlling the disease.

Experiments on crossing of mulberry silkworms have been continued at Pusa with a view to see whether the mongrel races will continue to give silk superior in quality and quantity to that of the indigenous multivoltine races.

In *Bengal*, cross-breeding experiments are in progress. Three of the most promising hybrids are under trial on a field scale, but as yet it is too early to say if the margin of improvement noticed will continue under ordinary conditions of rearing. The observations made in regard to the habits of the silkworm and the effect of the environment on the capacity of the worm for production of silk tend to confirm the evidence that the rearing of seed cocoons in the hills invigorates succeeding generations, at least up to the third, with a distinct increase in productive power.

The work of seed production expanded by about 35 per cent., and the total sales amounted to Rs. 84,000 as against Rs. 62,000 in the preceding year. The area under mulberry is

reported to have further increased by about 1,000 acres on account of the fact that the high prices now obtained for silk are inducing a larger number of people to take up the industry.

There are two sericultural schools in Bengal, one at Rajshahi and the other at Berhampore. Ten boys successfully passed during the year from the former and five from the latter school. Each pupil who passes the final examination of these schools receives a reward of Rs. 250 to enable him to build a model rearing house to carry on the improved methods learnt at the schools.

Silk seed reared in the *Punjab* during the year amounted to 1,000 ounces as against 872 ounces in the preceding year. There has been an increase both in the number of districts and in the number of people employed in silkworm-rearing. With a view to extend the industry, arrangements have been made to have definite estimates of the number of mulberry trees growing in the districts where sericulture is possible.

A scheme for opening sericultural farms at Kollegal, Coonoor and elsewhere in *Madras* at a cost of Rs. 1,50,000, is under the consideration of the Local Government. Meanwhile, the Sericultural Expert and his staff are engaged in demonstrating improved methods of rearing silkworms and reeling silk.

In the *Travancore State*, experiments with the different varieties of mulberry and silkworms were continued. The Philippine and Italian varieties of mulberry, got down from Pusa, are thriving. Several successful crops of silkworms were raised and the seeds were distributed among the village rearers.

In *Mysore*, during the last six years the production of silk has nearly doubled. It now stands at about a million pounds per annum worth over a crore of rupees. The Sericulture Department of the State is reported to have made satisfactory progress during the year in dealing with all problems connected with the industry.

## VIII. Miscellaneous.

Besides work relating to culicifuges and surra, the following subjects were under investigation by the pathological

entomological staff at Pusa, but no definite results were obtained during the year.

(*a*) The effect of X-rays on mosquito larvæ (carried on in collaboration with Captain Barnard of Colaba Hospital).

(*b*) The role of blood in ovulation of mosquitos.

(*c*) The behaviour of bed-bugs in varying temperatures.

(*d*) A study of the activities of the parasites of Tabanidæ.

(*e*) A study of the parasites of birds.

(*f*) The correspondence of the toxicity of volatile organic compounds to their boiling points.

(*g*) The effects of depressants on rats. Small doses of cocaine mixed up with *bajra* flour, formed into a dough and made into small balls, were offered to *Mus rattus*. The rats were kept singly in cages. At the end of three days the rats developed peculiar symptoms; they grew wild and bit at cage bars and other materials when offered to them. On the eighth day they showed cannibalistic symptoms and destroyed one another.

The experiments started with a view to finding out the correspondence, if any, between the toxicity of salts and their position in the periodic system were concluded. The results have been reported in the Scientific Reports of the Agricultural Research Institute, Pusa, for 1919-20.

## CHAPTER IV.

## AGRICULTURAL ENGINEERING.

It can be safely said that up to the present the agriculturist owes more to the artisan and the engineer than to any other outside agency. Indigenous cultivation in India, for example, is still entirely dependent upon the village artisan who fashions the plough and the water-lift, while the splendid systems of canal irrigation are solely due to the efforts of engineers. The engineering sections, which have of recent years been attached to the Agricultural Departments in the provinces, are thus merely an expression of the need which has been felt of a further improvement in cultivating implements and water raising machines and of extending the work done by the Irrigation Department to subsoil sources of water supply.

The early work of the Agricultural Department showed that, apart from improvement of crop yields by plant selection and manuring, much could be done by the use of more efficient implements. The establishment of engineering sections under technical experts may thus be regarded as a very distinct advance which is bound eventually to lead to an all-round improvement in the agricultural efficiency of the country. The improvement in the subsoil water supplies for irrigation and of water-lifts are essential to the welfare of large areas and to the development of the more valuable crops such as sugarcane, etc. Extensive sources of under-ground water have already been located in places subject to scarcity, such as in the Upper Gujarat and the Thana District in Bombay, sufficient, it is estimated, to turn these areas into a garden.

Unfortunately, shortage of staff has continued to militate against material progress in several of the provinces. Bombay, Madras, the United Provinces and the Punjab still continue to be the only provinces whose provincial cadres include permanent appointments of agricultural engineers. Two posts of agricultural engineers outside the departmental cadres have, however, been recently sanctioned for Burma and Bihar and Orissa, while the former has employed temporarily an engineer

lent by the Public Works Department. In Bombay and the United Provinces, the work, especially in the boring branch, is increasing rapidly, and the time has come for strengthening the engineering sections in these provinces.

In **Bombay**, well-boring, for which there is much demand, had 127 successful bores to the credit of the department as a result of the year's work.

Experiments with power plants, driving pumps, cane crushers, etc., have given valuable experience, and the Agricultural Engineer has designed and erected many such plants for landowners.

In **Madras**, the Agricultural Engineer completed the erection of 18 pumping plants and supervised 144 ryots' pumping installations maintained by the department. Bore-holes were put down to the number of 402 with an average depth of nearly 390 feet. Of these, 290 struck springs two of which were artesian.

The Government sugarcane-crushing and *jaggery*-making factory at Pallapalaiyam near Coimbatore was continued under the Agricultural Department. Notwithstanding the higher prices charged during the year for cane crushing and evaporation of the juice, the general opinion amongst the ryots was that it paid them better to employ the Government factory than to have the work done with ordinary country mills and country pans.

In the **United Provinces**, there was a widespread demand for machinery of all sorts, *viz.*, engines, pumps, rice hullers, threshers, tractors, etc., which, on account of shortage of stock, could not be met except to a small extent. At the close of the year, six tube-wells with engines and pumps had been completed and set to work, whilst eight more were in the course of construction. Trial borings led to 130 successful wells out of 206 borings made, while the supply of 377 wells, out of 524 operated upon, was increased. The demand for power sugar mills is particularly great. The following quotation from the report of the Agricultural Engineer on power cane-crushing mills is significant:—

"I erected a crushing mill and oil engine for a small zemindar in Gorakhpur District last season. The mill crushes about

27 maunds (a ton) per hour. The man, after one season's working, has now come to me for a mill three times the size for next season's work. He dealt last season with at least one lakh of rupees worth of produce with the plant I erected, and his profits must be in the neighbourhood of Rs. 30,000 for the season's work. The total cost of the plant, engine and mill, including erecting charges, was only Rs. 5,000. He will be working next season with a much bigger plant, and, in consequence, his profits will be much bigger."

In the **Punjab**, the number of borings during the year showed a slight increase as compared with last year's figures, *viz.*, 360 as compared with 349. The percentage of successes rose from 77·6 to 84·3—a very fine performance on the part of the staff. Work on tube wells is in progress at Jallalabad, Lyallpur, Muzaffargarh, Lahore and Bahawalpur. The Agricultural Engineer is also engaged in designing a power boring machine to suit the Punjab soils and a *bhusa*-making plant. The latter, if successful, would undoubtedly enable the department to make a new advance in tackling the wheat threshing problem in North-West India, which has never yet been satisfactorily solved.

In **Burma**, numerous problems await solution, and requisitions for advice on implements, machinery, land improvement schemes, etc., are increasing. In comparative tests between iron and wooden sugarcane-crushing mills, the Hathi iron mill, the price of which is moderate, gave favourable results as compared with existing wooden types, and it is stated that it would give still better results with larger rollers. As the iron mill has driven out the wooden crusher in most parts of India through sheer efficiency, the problem really resolves itself into test of the efficiency of the different makes of iron mills rather than between wooden and iron types. Tests with different types of threshers were also carried out.

In **Bihar and Orissa**, the number of borings to increase the supply of wells was 60. The majority gave great satisfaction. The suitability of strainer tube wells to Bihar conditions requires further study.

The **Central Provinces** could make little headway in this line without an engineering staff. An Agricultural Engineer, however, has been recently appointed.

In **Mysore**, a new design of plough was brought out during the year. It is now under trial by 40 leading agriculturists at different localities. Much work was done in altering and testing *jaggery*-boiling furnaces, and a saving amounting to about 30 per cent. in fuel was effected.

In the **Baroda State**, 40 successful borings to increase the supply of wells were made during the year. The rock-boring machine recently introduced was particularly useful. The use of power in the boring operations was found advantageous on account of scarcity of labour. The State advanced Rs. 20,000 to agriculturists for setting up oil engines and pumps and, in addition, a sum of Rs. 10,000 to enterprising cultivators for the purchase of tractors.

The introduction of **agricultural motor tractors** in considerable numbers during the year would seem to indicate that the field for their use may not be so limited as has hitherto been supposed. The need for supplementing the cattle power of the country has been felt for some years back, and this has been brought prominently before those who have been able to grasp the significance of improved tillage in the scheme of general agricultural improvement. The development of such crops as sugarcane depends on more extensive tillage just as much as on increased supplies of manure and water.

Further, the possibilities of the alleviation of some of the aftermaths of famine years are attractive to contemplate. It is thus not a matter of surprise that so much interest has been taken in India in the development of the agricultural motor tractor. It must be acknowledged, however, that the problem as applied to India is by no means solved, and that disappointment must be the inevitable result of too sanguine a view. The case of the agricultural traction is not so simple as it looks, and it is quite unsafe to base opinions as to the suitability of this form of power from the analogy of the motor car. An agricultural tractor is called upon to do a full day's work for long stretches on end. There is no such thing as easing up as in a

motor car and, except at the turnings, the engine is called upon to work at high pressure all the time. In these circumstances, especially in a tropical climate, rapid deterioration of the wearing parts is to be expected and the bill for lubricating oil is bound to be heavy. If these facts are borne in mind and too much is not expected of the motor tractor in India until defects have been remedied through experience of local conditions, all will be well. On the other hand, much will be lost through either an over-sanguine view or through a hasty judgment demanding impossibilities from a form of power, which, as far as its agricultural application is concerned, is still in its infancy.

## CHAPTER V.

## DISTRICT WORK.

The large majority of the Indian ryots are wholly or partly illiterate, and the usual methods of suggesting improvement in agriculture through the medium of leaflets, circulars and even lectures, in vogue in the more advanced countries, cannot be relied upon to anything approaching the same result. Ocular demonstrations are, therefore, resorted to, wherever possible. For this, use is made of Government seed and demonstration farms, implement depôts, etc., and private seed farms. The small plots in the cultivator's own fields, are, however, the most convenient means of assuring the agriculturist that suggested improvements can be actually carried out by himself. The whole question of demonstration, however, although important, is simple, and consists in possessing an adequate and properly trained staff and in a proper organization built on experience.

The advantages of improved strains of the various crops suited to varying conditions, improved implements, use of organic and inorganic manures, and more thorough methods of cultivation, co-terminous with the sale and distribution of better seeds, implements and manures, constitute the bulk of the district work of the Agricultural Department in all provinces. Other items such as the improvement of supplies of irrigation wells, the reclamation of soils, drainage bunding, etc., are of varying importance, and it is thus necessary to mention briefly some of the main features of the year's district work in each province.

As the result of successful demonstration carried out by the **Bombay** Department of Agriculture, in spite of high prices, there are now many parts of the presidency where iron ploughs are in regular use in large numbers. In some tracts ploughs owned by private individuals are now to be had for hire. The rise in prices and the short supply of implements have momentarily checked the introduction of harrows and seed drills, but there can be little doubt that there is a future for such in India.

The use of sulphate of ammonia for application to the sugarcane crop is spreading in many tracts. A demand is springing up for bone-meal for application to paddy on laterite soils. Better methods of cultivation and the use of selected varieties of various crops are becoming more common. A welcome innovation has been the starting of a seedsman's business by the Union Agency to whom the local department has been able to hand over part of its commercial transactions.

In **Madras**, the process of manufacture of *jaggery* was demonstrated to the cultivators in the neighbourhood of Palur, and that of making brown sugar at Kampli where the sugar prepared by the process demonstrated was sold at a considerable profit to the growers. Cane growers were given every assistance by trained workmen in constructing improved furnaces and making better *jaggery*.

Large quantities of the seed of improved varieties of cotton were distributed through the agency of the department and of the co-operative seed unions. The sales of cotton effected through the Coimbatore Marketing Association resulted in securing for Cambodia a much better price than Broach, to which up to last year it was considered equivalent in quality.

District demonstrations of the value of various manurial substances, such as fish guano, fish manure, oil-cakes, bone-meal and phosphates, are reported to have been highly successful. Phosphatic manures in particular appear to be much needed in many localities. Their successful introduction is mainly a matter of finance and organization of supply.

Some of the co-operative societies did good work in assisting agricultural demonstrations and in arranging the joint purchase of implements, cattle food, seed and manures, and in the manufacture of *jaggery*.

In **Bengal**, public interest in agricultural matters, and consequently the scope for district work, are increasing. Several offers of free sites for demonstration farms have been received from individuals and public bodies such as District Boards; in the latter case accompanied by promises of subscriptions towards up-keep. The Director of Agriculture remarks that "it would appear that the machinery is at hand for putting

into practice, on a very wide scale, the improvements which the Agricultural Department recommends. The only way, however, in which all this potentially useful energy can be properly controlled and made the most of, is by a further considerable increase in the number of agricultural officers and demonstrators, and it is hoped that sufficient money will soon be available for this purpose."

There are several Government seed stores and a larger number under local organizations, but it is becoming increasingly difficult to cope with the increasing demand for improved races of rice, jute and sugarcane, and a larger number of seed stores are required. Now that the cultivator has realized that it is worth while to pay a higher price for the seed of better varieties, there would appear to be room for private enterprise to take up some of this work from the department.

Progress has been made in the formation of small agricultural associations serving *thanas* or even smaller areas for the testing of improvements suggested by the department. It is pleasing to record that the activities of a large number of these associations extend to practically every phase of agricultural work, including the re-excavation of old irrigation tanks and other small irrigation schemes. Two of the district associations undertake the publication of agricultural magazines in the vernacular. Several District Boards, Khas Mahals and Court of Wards estates employ officers of their own to carry out agricultural demonstrations.

In September 1919, a devastating cyclone passed over the districts of Khulna, Faridpur, Bakargunj, Dacca and Mymensingh in Bengal, and did great damage to stored grains, standing crops, fruit trees, cattle, etc. All available agricultural officers were immediately put to relief work, and as the sowing season had already begun and seeds were not available at reasonable rates, about 27,000 maunds (950 tons) of seeds of different kinds were at once imported from Calcutta and offered to cultivators on loan or sale, as they chose. Many thousands of cultivators, who had not ready money to buy seeds with, were thus enabled to obtain what they required on loan, while others obtained them at reasonable rates.

In **Bihar and Orissa**, owing to an attenuated staff, consolidation rather than extension has been found necessary. Agricultural Inspectors and *Kamdars* (trained cultivators) are, however, engaged in demonstration work connected with the cultivation and extension of Pusa wheats, groundnut, sugarcane, etc., the seeds of which were distributed in large quantities. Some of the co-operative societies have proved very valuable as agencies for propaganda work, and have dealt with very large quantities of seed of Pusa wheats and Bengal Indrasail and Dahia paddies. While these societies are taking more and more interest in agricultural matters, it is significant to note that the majority of the larger district agricultural associations have remained practically inactive.

The Agricultural Department took a prominent part in the Provincial Agricultural and Industrial Exhibition at Patna in December 1919.

In the **United Provinces**, the Government depôts for the sale of improved seeds, manures, implements, etc., made large transactions and showed a fair margin of profit, but the work is growing beyond the capacity of the department to deal with it and, where possible, is being gradually entrusted to co-operative societies. The number of private firms dealing with the distribution of seeds is increasing. Such enterprises constitute the basis for the development of a really sound economic organization of the seed supply.

Land improvement schemes, such as the reclamation of ravine and *usar* lands, are also being carried out. About 10 acres of typical ravine land have been reclaimed and are now fit for cropping. Fairly good crops of wheat and paddy have been obtained from some of the plots of *usar* land under treatment. A plot of one-third acre gave an outturn of 170 lb. of Java indigo seed in the second year.

In the **Punjab**, about 473 tons of wheat and about 1,260 tons of cotton seed were purchased and sold during the year. The transactions yielded a net profit of about Rs. 1,34,126. A further amount of 114 tons of *juar* seed were sold to cultivators. A sum of Rs. 4,19,000 has been allotted during this year for the distribution of seed of improved strains.

Owing to high prices of material, the number of imported implements sold during the year was limited to 432, but 2,380 implements manufactured by the Agricultural Department were disposed of.

The agricultural associations, of which there are now 11 in the province, performed a good deal of useful propaganda of improved methods of cultivation and sale of the necessary implements. The grain elevator at Lyallpur which has a maximum capacity of 3,570 tons has been in work from June 1920. Up to the end of August, it had taken in 1,760 and discharged 660 tons of wheat.

Fourteen cotton sales were held. The amount of cotton disposed of in the sales was 1,910 tons.

In the **Central Provinces**, the seed and demonstration farms and also the demonstration plots were run at a profit. This is an important achievement as financial considerations must always be a limiting factor in the development of district work. At Chanda, with an expenditure of about Rs. 3,900 on three demonstration plots, a profit of Rs. 1,115 was shown. A comparative test carried out in 26 villages in the Chattisgarh Division showed a balance in favour of transplanted rice over broadcasted of over 600 lb. of paddy per acre, an increase equal in value to Rs. 25 per acre. The sale of rice seedlings for transplantation met with instantaneous success in Jubbulpore Division. Large quantities of seed of improved varieties of paddy, wheat and cotton and setts of sugarcane were distributed. Implements worth about Rs. 19,000 were sold during the year. The improved *gur*-boiling furnace designed by Mr. McGlashan, containing a most efficient design for stoking, effects very considerable economy in fuel supply and also in cost of erection.

In **Assam**, the result of the work on sugarcane is confirmed by the success which has attended the new varieties which have universally proved their superiority over the locally grown canes. A few demonstrations in Nowgong and Kamrup showed an average increase of 1,130 lb. and 1,037 lb. of *gur* per acre, respectively. There has been, in consequence, a greatly increased demand for sugarcane setts and for sugarcane mills. The demand for shallow boiling pans is increasing, and 33 pans

were sold during the last boiling season. The seed depôts at Gauhati and Sylhet, with budget grants of only Rs. 3,000 each, carried out transactions to the amounts of Rs. 24,488 and Rs. 15,246, respectively, on account of the introduction of the system of crediting receipts against expenditure. This system, which is contrary to the usual accounts practice, originated in Bengal, and can be recommended elsewhere. It is a direct inducement to making seed distribution self-supporting, and of course greatly facilitates the expansion of the work.

The system of terracing recommended by the department is increasing in popularity in the Naga Hills. This is an important piece of protective work bound to lead to valuable results.

Three tons of Kakya Bombai jute seed were sold to cultivators in the Surma Valley.

In **Burma**, district agricultural and co-operative societies were again found to be very useful agencies for dissemination of improvement. The demand for seeds of various improved varieties in many cases largely exceeds the amount which the department is in a position to supply. Nevertheless, some 1,000 baskets of pure strain paddy, over 9,000 *viss** of cotton seed, 3,000 baskets of wheat and 14,000 sugarcane setts, besides small lots of seeds of various other crops, were given out to growers. The services of the department were freely requisitioned for advice on varieties of subjects by firms, co-operative societies and private individuals. There was a good demand for iron ploughs and cane-crushing mills.

In **Mysore**, a good deal of useful work was done towards the introduction of improved implements, seeds and manures. The department held 1,498 demonstrations, had 2,775 transactions in implements (including plough shares), and distributed large quantities of improved seeds, manures and sugarcane setts. Another organization, which is playing an increasingly important role in the work of agricultural improvement in the State, is the Mysore Agricultural and Experimental Union. It co-operates with the department in carrying out tests of new varieties and improved methods of cultivation and in propaganda.

* A *viss*=3·65 lb.

The **Travancore State** maintained its activities in district demonstration work. Seeds of improved varieties of crops were distributed, and a large quantity of manures was sold by the department. As a result of the work, single seedling transplantation of rice is becoming a common practice, and in several places broadcasting is being entirely given up in favour of transplanting.

## CHAPTER VI.

## AGRICULTURAL EDUCATION.

The Agricultural Department is mainly concerned in training its own staff and in offering facilities for technical instruction in agricultural matters to those who desire it. It has, it is true, become involved in the question of rural education as the immediate result of the failure to teach Nature study in primary and secondary schools, but it is doubtful if the department, possessing, as it does, no knowledge of teaching or of the management of boys, can ever hope to do anything further than assist the education authorities in establishing Nature study or something akin to it on a sound footing in their schools.

For **higher agricultural education,** besides the Agricultural Research Institute and College at Pusa under the Imperial Department which deals with post-graduate courses, there are agricultural colleges in the provinces of Bombay, Madras, the United Provinces, the Punjab, the Central Provinces and Bihar and Orissa, and it is proposed to shortly open such institutions in Bengal and Burma. (Appendix II, pp. 115—119.)

The scheme for establishing an agricultural institute at Dacca in Bengal, drawn up by the late Director of Agriculture and approved by the Calcutta University Commission and by Government, aims at giving a thorough practical training in the various technical branches of this complex subject to young men who have aready been through a course in pure science. It is to be hoped that this attempt on the part of the Bengal department to turn out well trained men and not merely graduates will be given a fair chance. It is sure to be met with criticism by advocates of the examination system, but it is the considered scheme of a Government department which has learned by experience to value individuality and character.

A brief survey of the principal education activities of the year is given below.

In matters relating to agricultural education, as far as numbers are concerned, Bombay is still ahead of other pro-

vinces. The number of students in the B. Ag. course at the *Agricultural College at Poona*, which is affiliated to the Bombay University, is increasing and now stands at 203 compared with 170 in 1919 and 115 in 1916. Included in this number are students not only from adjoining provinces and States but from localities so far afield as the United Provinces, Bengal, Assam and Burma. An increasing number of the agricultural graduates now prefer to return to the land than to accept service. The University has also instituted a degree of Master in Agriculture. The results of the examinations were reported to be satisfactory.

In the *Agricultural College at Lyallpur* two distinct courses are arranged for—

(1) the degree course which is subject to University rules and regulations, and

(2) the certificate course.

The degree course takes four years and is divided into two parts, *i.e.*, two years for the first examination in agriculture corresponding to the F. Sc. examination, and two years for the B.Sc. in agriculture. The certificate course lasts two years. The tution and subjects in the first year are the same as for the degree course. In the second year, very little science is taught and the course is mainly in agriculture with some applied science.

Since the affiliation of the college to the University, the general qualifications of the applicants for admission have continued to improve. This year, out of 268 applicants only 54 could be admitted on account of shortage of accommodation. Out of 20 students sent up for the University degree examination, 17 passed, of whom 3 obtained first class. A gratifying feature is that the number of agriculturists turned out by the college is steadily increasing. Proposals for the institution of an M.Sc. course in agriculture are under consideration.

In addition to the degree and the certificate courses, there is also a vernacular course dealing with practical agriculture. During the year, 26 students were admitted to this course. The rural economy class consisted of 18 students, of whom two

were Assistant Commissioners, two Extra Assistant Commissioners and two Inspectors of Co-operative Societies. The teachers' class turned out 20 teachers with qualifications to teach agriculture in selected middle schools.

The system of giving wages to students in need of support, in return for services in the shape of manual labour, appears to be an excellent one and calculated to increase self-reliance and self-respect. Forty-eight students took part in the scheme during the year, some of them earning up to Rs. 22 per mensem.

Two courses of instruction—the certificate course and the diploma course, the latter in continuation of the former—were given at the *Agricultural College at Coimbatore*. Owing to the necessity for attracting a better class of students to the college than those seeking admission at present, it has been decided to separate the two courses from the beginning and to admit to the diploma course only such students as have passed the Intermediate examination of the University with physics, chemistry or a biological science as subjects. Twenty scholarships of the value of Rs. 25 each per month have been instituted by Government to attract better qualified students. It is however doubted whether these measures will have the desired effect. A scheme for the affiliation of the college to the University of Madras has been drawn up and submitted to the University for consideration.

Two hundred and twenty-two boys applied during the year for admission to the certificate course, of whom 49 were selected. Out of a class of forty-two, thirty-eight boys passed the certificate examination. Ten boys appeared in the diploma examination and all passed, two securing first class diplomas.

The *Agricultural College at Cawnpore* continued to give two courses of instruction—the higher or diploma course of four years and the lower or vernacular course of two years. The diploma course is steadily increasing in popularity among the sons of taluqdars and big landlords, and several are joining with the object of taking up agriculture as a profession. The vernacular course also continues to draw a satisfactory class of students, and such boys of the land-owning community as are not qualified educationally for the diploma course are getting

themselves admitted for this course. For this class of students it is necessary for the college to provide increased facilities for teaching estate management, a subject which cannot be taught adequately on a scattered farm of some 70 acres. A dairy farm will shortly be attached to the college.

The *Agricultural College at Nagpur* continued to give the students two courses of instruction—one of two years and the other of four years. All students start together whether they are likely to proceed to the 4-year course or only complete the shorter one. At the end of the first year there is a splitting off of the boys who obviously will never reach the longer course, but the examination at the end of the second year finally decides the selection for the longer course. Twenty-two students appeared in the examination at the end of the second year but only eight at the end of the fourth year. The figures are not encouraging, and it appears as if, as in other provinces, instruction in the two courses will have to be given separately from the beginning, and that, if possible, a better class of student should be secured for the longer or L. Ag. course.

The *Agricultural College at Sabour* in Bihar and Orissa continued to deal with a 2-year certificate course only. The chief development during the year was the appointment of a mechanical engineer to elaborate and teach a course of farm mechanics. Twenty-two students sat for the examination, out of which 17 passed. At the beginning of the session 1920-21 there were 68 regular students in the college, of whom 42 were from Bengal. Apart from scholarship holders, there are only six Bihari students.

Post-graduate work in agriculture and allied sciences is provided for at *Pusa*. During the year under report, 8 students availed themselves of the courses, two in mycology, one each in agricultural chemistry, entomology and agricultural bacteriology, and three in general agriculture. In addition, two students underwent a short training in general laboratory methods, one in the Mycological and the other in the Chemical Laboratory. Five students were given short courses in sericulture, while two students received instruction on the subject not amounting to a regular course.

The question of providing for post-graduate training of a higher order at Pusa with a view to turn out men qualified for direct admission to the Imperial Agricultural Service continued to engage the attention of Government. Schemes for the necessary expansion of the Institute together with a revised curriculum have been submitted to the Government of India and are under consideration.

The two **agricultural middle schools** on the Powarkhera experimental farm in Hoshangabad and on Chandkhuri experimental farm in Raipur in *the Central Provinces* did not prove much of an attraction to students belonging to the landholding classes for whom the schools are intended. They opened with 16 and 27 boys, respectively, on the rolls, but the numbers dwindled down considerably by the end of the year. The curriculum followed in these schools is somewhat technical. Practically everything taught has a strong bias towards agriculture, and the schools naturally do not meet the requirements of people who want their boys to take an intelligent interest in the general trend of the world's events. Apparently it is necessary to so revise the curriculum as to afford a general education to the students on a sufficiently broad basis. A third agricultural school is under construction at Yeotmal, while construction work on two more schools will shortly be started at Adhartal and Tharsa.

Steps are being taken to open two agricultural middle schools in *Madras*—one at Taliparamba and the other in the Northern Circars, possibly near Anakapalle.

In *Bombay*, six **vernacular agricultural schools** at Loni, Jambul, Alibag, Devi Hossur, Godhra and Mirpurkhas were at work during the year with a total of 131 boys on the rolls. In addition, 14 boys at the Bhil school near Dohad received a special short course of agricultural instruction on the Muvalia farm. These schools are doing useful work and there is no dearth of students except in the Mirpurkhas school. There appears to be some prospects for such schools, at any rate in the more prosperous parts of the Deccan. Six new schools were projected at Bagalkot, Karad, Niphad, Surat, Jalgaon and in Sind, but the schemes could not be carried through on account of financial difficulties.

In *Bengal*, the Agricultural Department has taken over the supervision of the scheme for imparting agricultural education in Burdwan District, through the agency of the Methodist Episcopal Church at Asansol, originally sanctioned in 1917, and has undertaken to revise, as an experimental measure, the teaching of agriculture in two secondary schools—one at Amarpur in Burdwan District and the other at Durgapur in Chittagong District—both of which are practically entirely financed by local effort. The Government agricultural school at Dacca, situated inside the agricultural station area, commenced its first session in January 1920 with the full complement of 30 boys. Unavoidable delay in the building operations has postponed the opening of the second school at Chinsura until January 1921. The primary object of these schools is to provide a sound elementary education for the sons of cultivators in a manner which will avoid instilling into them a desire to desert their traditional calling. The chances of success at Dacca, Chinsura, Amarpur and Durgapur are, on account of the employment of better paid and better trained teachers, considerably better than in the case of the older efforts.

In the agricultural school at Hebbal in *Mysore*, which imparts instruction through the medium of English, the entrance requirements have been raised and the length of the course has been extended to three years. This will enable a much more thorough training to be given to the men who are eventually recruited to the Agricultural Department. Eight students completed the 2-year course and passed the final examination held in April 1920.

The school at Chikkanhalli, which gives a vernacular course extending over 12 months, had a fairly successful year. Fourteen students completed the course and passed the examination.

In *Madras*, the farm schools and connected night-schools opened for the benefit of juvenile agricultural labourers on the Government farms at Pallur, Anakapalle and Coimbatore were continued. Although the students were paid a full day's wages for half a day's work done outside the school hours, the attendance was rather poor.

In *Bihar and Orissa*, nine students joined the **short courses** given at the Sabour college. Thirteen cultivators, of whom

7 were stipendiaries, were trained on the Government experimental farms.

In *Assam and Burma*, apprentices are trained on the Government farms for employment as demonstrators.

An interesting extension of agricultural education is the institution of a course for soldiers at the Jullundur demonstration farm in the *Punjab*.

## CHAPTER VII.

## THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

"If the system of co-operation can be introduced and utilized to the full, I foresee a great and glorious future for the agricultural interests of this country." It is now about nine years that these words were uttered by His Majesty the King Emperor. Since then co-operation has made rapid strides and has gone far afield: The development of agricultural credit societies has continued to make steady progress: Societies have been organized for joint sale of agricultural produce, for joint purchase and sale of articles for the improvement of agriculture such as manures and implements, and for such useful purposes as irrigation, the consolidation of holdings, etc.: The work of the societies has spread into many channels bringing practical and visible benefits not only to their members but also to the surrounding localities through the opening of dispensaries and schools, the introduction of improved methods of cultivation, of new crops, etc. However great in the aggregate, the percentage of the enormous agricultural population affected is of necessity still small. This is attributed to want of education among the people, and the spread of primary education is considered to be an essential step towards the successful inculcation of co-operative principles. Many co-operators are, however, keenly alive to the situation and are strenuously trying to spread education through organization of night school societies, etc.

The year's progress in co-operation may, on the whole, be considered satisfactory. The policy of the steady pruning of hopeless societies and the careful scrutiny of all new applications for registration has been rigidly followed by all provinces. Notwithstanding this, the number of agricultural credit societies has considerably risen and there has been a remarkable growth of reserve funds. While this may perhaps be considered as the best proof of the success in the year's transactions, it must be remembered that the financial prosperity of

the movement largely depends on favourable agricultural years. The beneficial influence of co-operation over members of societies is also reported to be bearing fruit. A sense of solidarity is being gradually built up and individual members are imbibing the spirit of self-help and habits of thrift. Cases of misappropriation of the societies' money by their office-bearers are not infrequent, but the evil appears to be lessening. In many places the cheap credit afforded by the societies has compelled the local moneylenders to lower their rates of interest. Closer relations between the Agricultural and the Co-operative Departments are, however, desirable. The organizing and developement of societies for the purchase of implements, seeds, etc., require the co-operation of both departments. (Appendix III, pp. 120—123.)

The following are a few facts and figures taken from provincial co-operative reports.

**Bombay.** The expansion of agricultural credit societies during the year has been remarkable. The number of societies increased from 1,648 in 1918-19 to 1,993 in 1919-20, the working capital from Rs. 81½ lakhs to nearly Rs. 1,08 lakhs, and the reserve funds from Rs. 5½ lakhs to Rs. 7½ lakhs. An equally remarkable increase, from Rs. 5½ lakhs to Rs. 8 lakhs, in overdue debts has, however, also to be noted.

The growth of non-credit agricultural societies was slower. Altogether there were 102 such societies in operation during the year. Of these, 26 concerned themselves with the supply of manures, 19 for the supply of seed, and 13 for the supply of implements. There were in addition 8 dairy societies; 14 for cattle-breeding purposes, 4 for cattle insurance, 12 for the sale of cotton and 6 for the sale of other agricultural produce. The twelve cotton sale societies sold 1,92,115 maunds of cotton for Rs. 30·40 lakhs, but most of the others proved disappointing. With a view to improve matters, the assistance of the local Agricultural Department has been enrolled and it is hoped that the joint efforts of the two departments will be successful.

The Co-operative Central Institute in Bombay has done useful work in organizing training classes for secretaries of co-operative societies. The classes were well attended and the instruction given is stated to have been valuable in improving

the work of the secretaries. The Institute issues the *Bombay Co-operative Quarterly Magazine* in English and vernacular monthlies on co-operation. A Provincial Co-operative Conference was held in Bombay in September 1919.

**Madras.** There was a net increase of 1,088 in the number of agricultural credit societies in the presidency, raising the total to 4,156. The total working capital rose from Rs. 1,22,95,570 to Rs. 1,56,86,228, reserve funds from Rs. 6,91,884 to Rs. 8,19,592, and net profit from Rs. 1,71,616 to Rs. 2,09,327. No improvement, however, is reported in the collections of overdue debts. Satisfactory progress appears to have been made in the admission of tenants and agricultural labourers to membership of societies. There was also an appreciable increase in the sums advanced to cover "cultivation" expenses.

The number of agricultural societies for purchase and sale rose from 31 to 58, membership from 1,891 to 3,339, working capital from Rs. 63,999 to Rs. 2,80,433, and net profit from Rs. 1,344 to Rs. 6,140. The Nidamangalam Agricultural Manure Society did good work during the year, and in addition to manures dealt in new varieties of paddy and coconut seedlings. The South Canara Garden Planters' Co-operative Wholesale Society dealt in areca nut, pepper, cardamoms, etc., to the value of Rs. 1,67,811. A sum of Rs. 25,000 is, however, reported to have been misappropriated from the society's funds. A few of the other societies appear also to have done good work.

**Bengal.** Agricultural societies increased in numbers from 3,923 in 1918-19 to 4,977 in the year under review. Ninety-two per cent. of these are credit societies, whose membership has risen from 128,471 to 147,923, and working capital from Rs. 86½ lakhs to Rs. 1,04 lakhs. The reserve funds show an increase by Rs. 2,06,426, while the overdue debts have undergone reduction presumably as the result of the favourable agricultural year. Most of the more unwieldy societies have been now split up and the bad cases have either been reconstituted or placed under liquidation.

The development of agricultural non-credit societies has been steady, the numbers increasing from 31 in the previous

year to 58 in the year under review. The irrigation societies, whose numbers increased by 4 during the year, deserve some mention. For example, the Salband society in Bankura, the largest of this type, provides for irrigation for 6,000 bighas and is extending its operations. The Khelar Irrigation Society in Midnapur District irrigated 1,000 bighas of land which yielded crops reported to be three times as heavy as those of the adjoining lands.

The Naogaon Ganja Cultivators' Co-operative Society made a net profit of Rs. $1\frac{3}{4}$ lakhs during the year, and continued its career of general usefulness in spheres other than *ganja* cultivation. To mention only a few of these, the society has decided to open an agricultural station and has acted as an agent in the distribution of tobacco seeds, sugarcane cuttings and Darjeeling red seed potatoes supplied by the provincial Agricultural Department. It sent three sons of *ganja* cultivators to the Rangpur experimental farm to learn tobacco cultivation, and spent Rs. 1,000 in making embankments. It has allotted Rs. 12,000 for opening a charitable dispensary in a suitable central place in the Ganja Mahal, has contributed Rs. 1,000 to the King George's Sailors' Fund and Rs. 1,500 to the Local Board for improving the roads. The society has also built and furnished a medical ward in Naogaon Charitable Dispensary, and has distributed cloth worth Rs. 1,400 among the indigent people in the Ganja Mahal. A qualified veterinary assistant has been appointed on a monthly salary of Rs. 75 to look after the cattle of the cultivators.

The Sundarbans Supply and Sale Society made a profit of Rs. 7,035; the society has now decided to erect granaries for storing, and to purchase machinery for husking paddy.

The Bengal Co-operative Organization Society, which also aims at being a central bureau of information and advice on matters relating to co-operation, continued to do useful propaganda work by means of lectures and through its organs, *The Bengal, Bihar and Orissa Co-operative Journal* and the *Bhandar*.

**Punjab.** The number of agricultural societies rose from 5,228 to 6,831, membership from 149,040 to 182,516, and work-

ing capital from Rs. 1,55,21,099 to Rs. 1,78,46,207. The amount of outstanding debt underwent considerable reduction. The largest increase has taken place in agricultural credit societies. Promising experiments are being made with societies for arbitration, consolidation of holdings, land mortgage redemption, irrigation, cattle-breeding, sheep-breeding, etc.

A co-operative land mortgage bank was started in the province during the year under review. In the very first month of its existence, it was able to redeem 500 acres of land belonging to 30 people for Rs. 36,874. It is the first bank of its kind in India and will serve as an object-lesson for other provinces.

As many as 20 societies with 690 members for the object of consolidation of holdings were formed during the year. Some repartition has already been wholly or partially completed with the result that each owner will now have one solid block of land in one place. The following is the principle on which the scheme is founded. Each individual applying for membership " must agree to the general principle of consolidation. He must promise to abide by any method of partition approved by two-thirds of all the members, and give up possession of his land for four years in accordance with any plan of repartition so approved. He must further agree that all disputes should be referred to arbitration. The possession given is cultivating possession for four years. At the end of four years, the old possession must be restored unless all the members unanimously decide otherwise. In the course of the four years, transfer of ownership is permissible. The society comes to an end in five years."

It is expected that the trial will make the advantage of consolidation sufficiently clear and will ultimately result in permanent exchange of ownership. It is reported that in some cases the owners are agreeing to permanent exchange straight away. The results of the working of these societies will be watched with the keenest interest by all those who realize the evils of scattered small holdings.

Co-operators as a body are reported to be taking a more lively interest in the improvement of agriculture. During the year, they were instrumental in selling a large number of im-

proved implements. Many of them now set aside small plots of land for the demonstration of new methods and for the testing of seed of improved varieties, while two seed and demonstration farm societies have been registered, one at Lyallpur and the other at Montgomery.

**United Provinces.** There was an increase in the number of agricultural societies from 3,186 to 3,498. Membership fell from 92,198 to 89,522, and the working capital from Rs. 51,90,778 to Rs. 48,13,537. The total reserve fund, however, rose from Rs. 9,05,913 to Rs. 9,10,015. The fall in membership and working capital is ascribed to the liquidation of some of the moribund societies which are a heritage of the past. One encouraging feature of the year was a decrease in arrears from 23·83 lakhs to Rs. 14·90 lakhs. This reduction is, however, not altogether due to realizations, the exclusion of the figures relating to the cancelled societies being in part responsible.

There were only eight non-credit agricultural societies in existence at the close of the year. One of the five societies which deal in *ghee* prospered. A new cattle-breeding society at Bijnor has been registered but has not yet started work.

**Central Provinces.** The number of agricultural credit societies rose from 3,871 to 4,421, membership from 62,612 to 71,039 and working capital from Rs. 69,40,497 to Rs. 93,27,320 or by 34 per cent. The societies made a profit of Rs. 1,63,246 as against Rs. 1,15,916 in 1918-19. The average number of members per society remained the same as in the past three years, but the average loan per member has risen from Rs. 100 in the preceding year to Rs. 131 in the year under review.

Recovery of loans has, however, been more satisfactory than in the preceding years, and it appears that members have begun to realize the necessity of punctuality in repayment.

Of agricultural societies for purposes other than credit, there are 5 for purchase and sale of agricultural implements, etc., 27 for production and distribution of pure seed, 2 for cattle-breeding and 1 for cotton ginning. Two of the associations for purchase and sale are reported to be doing good work, while the others are said to be "yet feeling their way to make

a move." The Berar unions for production and distribution of pure seed had a fairly good season and put out 3,327,253 lb. of *roseum* cotton seed, but the unions in the Northern Circle, excepting the one at Betul, did not fare so well. Most of them, however, continued to do useful work in propagating pure seeds and hiring out improved ploughs, etc. The two cattle-breeding societies in the Raipur District continued to do good work, while the cotton ginning society at Paras in the Akola District attained greater success than in the last year and made a net profit of Rs. 1,562.

**Burma.** The number of agricultural credit societies rose from 2,675 to 3,319, individual membership from 57,709 to 72,816, working capital from Rs. 1,12,76,714 to Rs. 1,24,63,673, and reserve fund from Rs. 13,48,837 to Rs. 17,52,006. There was also no fall in the average standard of repayments. The average membership of rural credit societies is, however, still below 22, and the average working capital per member declined from Rs. 195 to Rs. 171.

The colony societies are reported to have done well. The introduction of improved crops and implements and sale of crops are making steady progress. Through the co-operation of several societies amongst themselves an irrigation channel two miles in length was constructed.

**Bihar and Orissa.** The number of agricultural credit societies rose from 2,044 to 2,774, membership from 65,818 to 79,732 and working capital from Rs. 34,27,905 to Rs. 38,09,758. The profit made during the year was, however, Rs. 2,28,440 as against Rs. 2,41,605 in the preceding year.

The societies for sale of the agricultural produce of the members, of which there are 11 in the Khurda Sub-division, did useful work and succeeded in minimizing the middleman's profit to the extent of about five annas for every rupee worth of grain. The advantage of combination for marketing the agricultural produce is being appreciated by the ryots as is apparent from the fact that some of them have decided to erect a rice-hulling mill in the sub-division, where the cultivators would deliver their surplus grain after harvest and get the market price, and, after the year's account is made up, would

participate in the profit in proportion to the amounts of grain sold.

**Assam.** The number of agricultural credit societies rose from 333 to 412, membership from 11,465 to 18,520, working capital from Rs. 5,04,616 to Rs. 5,15,469 and reserve fund from Rs. 1,33,888 to Rs. 1,48,517 during the year under review. Of the 412 societies, only 7 are of the share type and all the rest of the Raifeissen type. There are as yet no societies for agricultural production or for the sale of produce.

## Co-operative Dairies.

It is satisfactory to note that there has been sustained progress in the formation of milk societies in the Barasat Sub-division of the 24-Parganas District in Bengal. The number of societies rose from 19 to 40 in the year under review, the number of members from 561 to 1,629, share capital from Rs. 638 to Rs. 1,526 and net profit from Rs. 2,212 to Rs. 2,578. The societies are now supplying, on an average, 3,000—4,000 lb. of milk per day to Calcutta, where on its arrival the milk is handled by the milk societies' union. It is reported that on account of a higher profit the members of the societies are now able to feed their cows better and to improve the sanitation of the milking sheds.

The co-operative societies of *goalas* at Nagpur continued to work successfully. The Amraoti co-operative dairy also worked economically and made a profit of Rs. 503.

In other provinces co-operative dairy societies have failed to make any satisfactory progress. There are eight such societies in Bombay and three in the United Provinces all of which are at present struggling for existence.

## Cattle Insurance.

The difficult work of introducing cattle insurance is making steady progress in the Punjab. The number of insurance societies has increased from 8 to 22. Of these, 21 are in Rohtak District, where a cattle re-insurance society has now been formed. The number of animals insured has increased from 372 to 587. Thirty-five animals came under treatment, of which

6 died and Rs. 347 were paid in claims. No claim has so far been made upon the re-insurance union.

In *Burma*, the central re-insurance society has now a reserve of Rs. 10,000 and a general fund of Rs. 5,600. It is considered to be strong enough to stand alone and the Government guarantee has therefore not been renewed. The central and primary societies have no veterinary or inspecting staff at present but they are attempting to have their own men trained up in the Insein Veterinary School.

There was a fall in the number of primary cattle insurance societies from 386 to 381 and from Rs. 2,15,398 to Rs. 1,69,767 in the total amount of risk insured. The societies paid Rs. 3,176 during the year in settling the claims on account of 166 animals lost. Outside Burma and the Punjab there is practically no progress in cattle insurance.

The only cattle insurance society in the *United Provinces* had to be dissolved during the year as the people failed to appreciate the value of such societies, while the four cattle insurance societies in *Bombay* exist on paper. In *Bengal*, the registration of the cattle insurance society at Taki has been cancelled. There is, however, a proposal to start a new cattle insurance society at Nāogaon under the ægis of the *ganja* society.

## CHAPTER VIII.

## LIVE STOCK.

### I. Prevention and Treatment of Disease.

Details of the work done by the Civil Veterinary Departments during the year under review are given in tabular form on page 124 (Appendix IV.) The large increase in the number of cases treated in hospitals and dispensaries and by officers on tour clearly indicates that steady progress has been made in winning the confidence of the agricultural population in the medical treatment of their live stock, an indispensable condition for the success of the work of the department. As a further testimony to this increasing confidence on the part of the general public it may be mentioned that in some provinces, for instance, in Bombay, Madras and the Punjab, private individuals have come forward with offers to establish veterinary hospitals at their own expense.

During the year, rinderpest prevailed in a virulent form in many parts of the country and was mainly responsible for the rise in the mortality under contagious diseases, the reported numbers of which rose from 2,63,372 in the preceding year to 3,37,396 in the year under review. The number of inoculations made was 7,09,795, but a far greater advance in this direction might have been recorded had it been possible to maintain a regular supply of serum from the Imperial Bacteriological Laboratory at Muktesar.

Although the veterinary staff has been strengthened in some provinces, the resources of the department continue to be inadequate for the proper performance of the heavy and responsible task set before it. In a country in which the bovine population alone exceeds 145,600,000 head, it is idle to expect real progress in combating disease with a comparatively small band of workers, however zealous they may be. The annual loss that the Indian cultivator suffers from preventible diseases of cattle amounts in the aggregate to enormous figures. These losses include not only the market value of the cattle which succumb to disease but include the set-back to production,

growth and vitality, as well as the loss and inconvenience incurred in field operations. In India, as in other countries, where the main stay of the farmer is his live stock, the necessity for a properly organized veterinary department is one of the very first considerations, and an appeal to figures to prove that the amount of preventible mortality far exceeds the cost of prevention seems scarcely necessary. It cannot be hoped, however, that the present annual expenditure of 352 lakhs on the department in India and Burma amounting to less than one-half anna per head of bovine population will go far to provide an adequate veterinary organization.

## II. Incidence of Disease.

*Bombay.* The year appears to have been a comparatively healthy one for stock, the recorded number of deaths from contagious diseases being 8,647 against 10,550 in the preceding year. The decrease in the mortality from rinderpest was particularly marked. Lymphangitis in cattle was recorded for the first time in the presidency and was found to be prevalent to some extent in the Kanara District. The disease is under investigation at the Imperial Bacteriological Laboratory at Muktesar. Meanwhile, cases are being treated by surgical methods.

Among equines, there were 154 reported deaths from surra against 149 in the preceding year. The disease was almost entirely confined to *tonga* lines. Every endeavour was made to instruct the owners of horses as to the nature of the disease, the manner in which it spreads and the methods of prevention. As a result of the precautionary measures taken, the Chimbur Pinjrapole remained free from the disease for the first time for a number of years.

*Madras.* The total number of deaths amongst cattle from contagious diseases dropped to 59,297 in 1919-20 from 76,114 of the previous year. There was a decrease under all diseases except anthrax, in which, however, the increase was negligible. Seven cases of surra were confirmed microscopically, but several deaths occurred from the disease amongst the buffaloes belonging to the Forest Department in South Coimbatore Division.

Heavy mortality amongst the sheep and lambs of the agricultural farms at Hagari and Bantanahal in Bellary District occurred during the year and many of the cases showed pneumonic lesions. From the Cattle Quarantine Depôt at Tuticorin, 9,918 cattle were passed for shipment to Ceylon against 4,919 in the preceding year, while at the request of the Colombo authorities, 7,807 animals were inoculated against rinderpest before they were shipped.

*Bengal.* Contagious diseases were responsible for 14,569 deaths compared with 15,569 in the preceding year. There was a very marked decrease in the death roll under anthrax, the number recorded being 88 only against 2,555 in the previous year. The mortality resulting from rinderpest and hæmorrhagic septicæmia was, however, greater than in the past year, inspite of the fact that a large number of animals were protected from the ravages of diseases by timely inoculation. A prominent feature of the year was the appointment of veterinary union committees and sub-committees to deal with veterinary matters. Many of the difficulties at present experienced by the Veterinary Department could be easily overcome by a display of energy on the part of such organizations.

*Bihar and Orissa.* Outbreaks of contagious cattle diseases were on the whole less virulent and more localized in character, the reported number of deaths being 15,781 compared with 25,658 in the previous year. The scheme for inoculation of cattle in Chota Nagpur through the agency of a special staff of locally trained inoculators proved a failure and was abandoned towards the close of the year.

*United Provinces.* The mortality from contagious diseases rose from 16,233 in the preceding year to 42,715 in the year under review. Inspite of vigorous campaigns organized against the disease, rinderpest assumed a virulent form and levied a toll of no less than 32,572 animals. Surra appeared only in the district of Naini Tal, and 40 animals either succumbed to it or were destroyed under the Glanders and Farcy Act. Seven new hospitals were added during the year, raising the total number to 95.

*Punjab.* Contagious cattle diseases accounted for 56,089 deaths compared with 28,715 in the preceding year. The

increase in mortality is chiefly due to very severe outbreaks of rinderpest, aggravated by the debilitating influence brought on by the last fodder famine and consequent susceptibility of stock to disease. Surra was less wide-spread than in the previous year, while no cases of dourine were recorded, probably due to the thorough measures adopted by the department against the spread of this disease. The foot bath erected for the stock at Hissar was again successful in diminishing the feet deformities which usually follow untreated cases of foot-and-mouth disease.

*Central Provinces.* The number of deaths from contagious diseases was 33,052 as against 21,344. Rinderpest was wide-spread throughout the province and took a virulent form in many districts. The measures adopted in the suppression of surra appear to have been effective, only 81 fatalities being recorded as against 264 in the preceding year. A new dispensary was started at Warora, bringing the provincial total to 81. More applications have been received for the establishment of new dispensaries and are under consideration.

*Assam.* The year was an unhealthy one for live stock and there was a considerable increase in the number of deaths reported from contagious diseases, the figures rising from 20,819 in 1918-19 to 39,188 in the year under review. Rinderpest alone caused 16,242 deaths compared with 7,239 in the preceding year, while deaths from foot-and-mouth disease and hæmorrhagic septicæmia were 79 and 93 per cent. more than in the previous year. There was an extensive outbreak of surra in Maulvi-bazar Sub-division of Sylhet District. The disease was also detected in four other districts where, fortunately, it was not so wide-spread. The unhealthiness of the season emphasized the difficulty of coping with extensive out-breaks of contagious diseases with the existing staff. The question of increasing the number of reserve officers for such contingencies is under consideration.

*Burma.* Rinderpest caused a heavy death roll, the mortality being more than double the number recorded in the preceding year. To the apathy of cattle owners and their neglect to conform to the rules framed for the prevention of disease is

ascribed the responsibility for the wide-spread mortality. Foot-and-mouth disease prevailed with varying degrees of intensity throughout the year and caused considerable anxiety. Several cases of surra were recorded including one calf and one dog. The disease was also prevalent in the Shan States and was especially bad on the Taunggyi-Kengtung Road throughout the rains.

*North-West Frontier Province.* During the year, 30,090 cases of contagious diseases were reported, of which 3,087 proved fatal, compared with 31,293 cases and 7,224 deaths in the preceding year. The deaths were mostly due to rinderpest. One hundred and six cases of surra occurred during the year, resulting in 75 deaths.

*Sind.* The year on the whole was a healthy one for stock. The mortality from contagious diseases was low, the total number being 1,688 against 4,125 in the previous year. There was however a slight increase in mortality due to surra and glanders. Seventy-two cases of the former occurred among equines and six among camels all of which terminated fatally except one case of a horse which recovered under treatment. Twenty-six cases of glanders were detected against six in the previous year.

*Baluchistan.* The number of reported deaths from contagious diseases was 3,277 as against 6,442 in the preceding year, but the Superintendent, Civil Veterinary Department, in charge of the province, reports that no reliance can be placed on the statistics, and it is certain that many outreaks of contagious diseases were not reported at all. Appreciable improvement in the control of contagious diseases cannot be reasonably expected until a separate Superintendent for the province is appointed.

*Rajputana.* The total mortality from contagious diseases was reported to be 252 against 128 in the preceding year. No outbreaks of epidemic disease were reported from Merwara during the year, but it is very improbable that none occurred.

### III. Preventive Inoculation.

The combating of animal disease is a struggle against unseen enemies. So swift are the attacks of some of the contagious

diseases, *e.g.*, rinderpest (cattle plague), hæmorrhagic septicæmia and anthrax, that after the appearance of visible symptoms, little can be done to save the infected animals. Treatment is not of much avail, and from 75 to 99 per cent. of affected animals are generally lost. A glance, however, at the table given below of the consolidated figures of the results of preventive inoculation shows the enormous possibilities of such work.

| Disease | Number of outbreaks in which inoculation was undertaken | Deaths uninoculated | Inoculations made | Deaths after inoculation | Percentage of deaths in inoculated animals |
|---|---|---|---|---|---|
| Rinderpest . . . . | 4,882 | 67,761 | 680,993 | 2,468 | 0·35 |
| Hæmorrhagic Septicæmia . | 618 | 3,054 | 130,555 | 64 | 0·04 |
| Anthrax . . . . | 85 | 555 | 8,811 | 19 | 0·22 |
| Black Quarter . . | 41 | 90 | 6,372 | 23 | 0·36 |

For rinderpest, for example, where the normal mortality is 75 per cent., the actual deaths amongst the 681,000 animals inoculated with anti-rinderpest serum amounted to only 0·35 per cent. It would thus appear that complete prevention of rinderpest depends on two things: (1) the provision of a sufficiently large staff of inoculators; (2) the co-operation of the people themselves.

The year's experience in the Yamethin District in Burma affords a convincing object-lesson to cattle owners as to what can be done through co-operation to check disease. A bad outbreak of rinderpest was very successfully and speedily controlled through the prompt action of the people themselves in reporting the disease and carrying out the instructions of the Veterinary Department. Not only was the disease controlled in the affected villages but its spread to other districts prevented.

Owing to the very satisfactory results obtained, vaccination against hæmorrhagic septicæmia is steadily increasing in popularity. Vaccination in this case reduces the death rate of vaccinated animals to 0·04 per cent. although the mortality among affected animals is as high as 75 to 90 per cent. Requests

are now regularly received from certain low-lying tracts liable to the disease, to have the cattle vaccinated before the commencement of the rainy season.

Prophylactic measures against anthrax, which ordinarily claims 95 to 99 per cent. of cases, have also been highly successful. Results of injections made indicate that the mortality among inoculated animals does not exceed 0·22 per cent.

In Madras, the District Magistrates concerned were asked to exercise the powers vested in them by the Cattle Diseases Act, and to close those fairs to which contagious diseases were known to be imported, but in many instances the people again held unauthorized gatherings of cattle, the result being that diseases could not be got under control as quickly as was expected. The Act was in force in the Nilgiris throughout the year, in Kodaikanal Taluq for three months and for varying periods in South Arcot and in parts of Coimbatore and Tanjore Districts. In Burma, the Village Act which deals with diseases of cattle was amended by the omission of the proviso that before cattle are inoculated the sanction of the Commissioner must be obtained. This, if applied, would only cause delay in dealing with an outbreak.

More efficient measures to prevent the spread of disease are undoubtedly required. Usually mortality is particularly high in districts where cattle pass continually between markets and grazing grounds—a fact which clearly points to the necessity of legislative measures, in some form or other, restricting movements of diseased cattle from one locality to another and the compulsory segregation of infected animals.

Surra has now been notified as a disease to which the Glanders and Farcy Act applies.

## IV. Breeding.

(*a*) ***Cattle-breeding.*** The heavy decrease in the cattle population in parts of India brought to light by the last cattle census has been a revelation to many, and has naturally caused a good deal of anxiety in certain quarters. Epidemics of disease and fodder famines are no doubt the two main causes of the decrease. The failure of the cultivating districts to make

up the deficiency is remarkable and can only be attributed to the fact that cattle-rearing, inspite of the high prices of draught animals, is still less profitable than crop-growing. That things will ultimately adjust themselves to a balancing of supply and demand may be safely asserted, but this will only occur after the price of draught cattle rises to the cost of production on the arable areas. While, therefore, the main hopes in checking still further decreases lie in the prevention of disease and in protective famine measures, a very important aspect is the cheapening of the cost production of cattle in the crop areas. It is held by many that the main obstacle to this is the poor milk yield of the average cow and that until this can be raised it will not be possible to rear good cattle in the arable areas at anything but exorbitant prices. The problem would therefore appear to be closely connected with the improvement of cattle from the dairy point of view, and as this is a matter of considerable urgency owing to scarcity of milk supplies for the cities, there is a strong case for the milking properties not being lost sight of in breeding cattle for the arable areas. The efforts of the Veterinary Department to improve the working cattle are now being supplemented by the work of the Agricultural Department in breeding higher milk-yielding cows, and it seems only reasonable that, after milk pedigree has been fully established on a sufficiently large scale in India, the operations will be merged into a joint effort to combine the qualities of milk and draught in the same breed. When the results of selection for draught purposes carried on by the Veterinary Department are sufficiently advanced to permit of a further selection for milk yield, and where the breeding operations of the Agricultural Department for milk properties have reached a point which will admit of the rejection of all non-draught types, real progress will be possible. In the meantime neither can be said to have reached that stage and the work already in progress will probably run along parallel lines for some time to come.

The milk side of the question has, however, received a considerable impetus through the appointment of an Imperial officer to take charge of dairying and by the co-operation of the Military Department whereby the surplus male stock of the

military dairy farms has been put at the disposal of the Agricultural Department. The result will undoubtedly lead to a large increase in the number of milk pedigree animals in the country, and has already led to the inauguration of schemes for the improvement of the many excellent breeds of Indian cattle on lines of milk production.

The following is a brief summary of the provincial programmes :—

In the *Punjab*, the Dhanni cattle-breeding scheme, of subsidizing private breeding operations, which was started in the Dhanni tract about a year ago, has so far given very encouraging results, and has appealed to the zemindars who do not like to undertake the responsibility of keeping bulls supplied by the District Board. It is hoped that, with proper supervision and continued financial assistance to the scheme, the famous Dhanni or Awankari breed, which for some years has been in danger of extinction, will be re-established in its original home. The District Boards of Attock, Jhelum, and Rawalpindi have started schemes for breeding Dhanni cattle without direct assistance from Government.

The increase in the price of cattle is reported to have given a stimulus to more careful breeding and has created a demand for well-bred bulls. Every endeavour is made by the Veterinary Department to impress on zemindars the necessity for retaining the best bulls and for the emasculation of unsuitable ones.

The Hissar farm is the premier cattle-breeding station in India, the number of live stock on the 31st March amounting to no less than 5,828 and valued at Rs. 5,19,108. Sales amounted to Rs. 1,81,231, the chief customers being local District Boards, private breeders and exporters. There are now 1,352 bulls chiefly bred on the Hissar farm at stud in the province, and the demand is steadily rising.

Steady progress has been made in the *Central Provinces* where there are now 10 cattle-breeding farms at the following places, *viz.*, Hoshangabad, Adhartal, Raigarh, Sindewahi, Bilaspur, Drug, Borgaon, Khandwa, Telinkheri and Nagpur. With the opening of a farm at Khandwa for the Nimari breed, all the leading local breeds, *viz.*, the Malvi, the Gaolao, the Umardha, the Chattisgarhi, the Khamgaon and the Nimari,

are now represented. The primary object of the first eight of these farms is to improve the various breeds for draught purposes. All the different breeds are maintained pure, except the Gaolao and the Chattisgarhi breeds with which cross-breeding by Montgomery and Malvi bulls, respectively, is in progress. The present policy is to maintain as large herds as possible in order to produce the maximum effect on the cattle of the districts served by each farm. Some of the farms are already producing definitely better bulls which realize up to Rs. 230 each.

The Telinkheri and the Nagpur farms deal with milch cattle. Cross-breeding experiments with Montgomery bulls are in progress at Telinkheri and with Ayrshire bulls at Nagpur with a view to increasing milk yields. The former have so far yielded promising results.

In the *North-West Frontier Province*, cattle-breeding continues to make satisfactory progress. The marked superiority of the progeny of the District Board bulls over the ordinary village type is readily admitted by cattle-breeders. A much larger concentration of District Board bulls is however required. During the year prices for Dhanni bulls went up abnormally high, some owners securing up to Rs. 1,000 per bull. A herd of 45 Awankari cattle is maintained on the Peshawar agricultural farm. The young stock are well-grown and good looking specimens. The stud bulls are freely used by the neighbouring cultivators.

In the *United Provinces*, there are two bull-rearing and breeding farms at Kheri and Madhurikund, respectively, which deal with the two local breeds of cattle in the provinces, the Kherigarh and the Hariana. The former is a good, active, but small draught animal suited to the economic conditions of the eastern districts of the provinces but useless as a milker; while the Hariana has some pretentions in the way of milk. Accordingly, the scheme for this breed involves a system not only of standardizing draught conformation in the bull but of milk tests in the cow. Cross-breeding experiments with Hissar, Sahiwal and Kosi strains are in progress. At the close of the year there were 284 head of cattle on the Kheri farm and 273 on the Madhurikund farm.

An ensilage tower with a capacity of about 190 tons is under construction on the Kheri farm for preserving and testing the utility of jungle grasses to provide for famine years.

It has been decided to hand over the district cattle-breeding operations to the local Agricultural Department, and to retain the breeding farms under the Veterinary Department which will continue to act as supplying depôts for stud bulls until such time as the Agricultural Department has established its own institutions.

The establishment of a dairy demonstration farm at Lucknow is under consideration. Several municipalities have been induced to devote attention to the production of clean milk and the establishment of dairies.

In *Bihar and Orissa*, in addition to the herd at Sipaya, milch cattle are maintained at Ranchi and Sabour by the Agricultural Department. At the end of the year there were 80 breeding cows in the Sipaya herd, 25 in the Ranchi herd and 28 at Sabour. In view of the necessity of rigid selection and the desirability of combining milking and draught qualities, it has been decided to reduce the size of the herd of the pure Sipaya type, and to cross the cows that do not conform sufficiently to that type with a Montgomery bull of a good milking strain. The small herd at Ranchi shows possibilities of improvement in milking strains. A herd of buffaloes is being maintained at Neterhat with a view to distribute young bulls in the neighbourhood.

The success of the district cattle-breeding scheme, inaugurated in the Shahabad District, indicates that there are possibilities of improving local breeds by the distribution of good bulls in selected districts.

In *Bengal*, there are two cattle-breeding farms—one at Kalimpong, consisting mainly of Siri cattle and managed by the St. Andrew's Colonial Homes, and the other at Rangpur the basis of which is indigenous cattle. In the latter farm, both *deshi* and imported Hissar bulls are used on the same class of cow. The off-springs of the Hissar bulls seem to be quite promising and are described as having broad chests, docile habits, stout legs and to be mostly of grey colour. This year's

progeny from these bulls numbers 58. There are 347 head of cattle on this farm.

In *Bombay*, cattle-breeding operations are in charge of the Agricultural Department. Pedigree bulls of the Kankreji breed from the Chharodi and Surat farms, and Karachi bulls from the College Dairy Farm are distributed to districts. Kankreji bulls are being put out on the premium system. Khillari bulls are being purchased in the open market to supply to breeders in the Deccan, but as nothing is known about their pedigree and as they have to be judged by appearance only, the results are not as satisfactory as they might be. The buildings for the Bankapur cattle farm are nearing completion, and pure bred Mysore cattle are being purchased to form the nucleus of a herd. It is expected that this herd will, in time, supply bulls to the Southern Mahratha Country and very possibly to a considerable part of the Deccan. The experiment for utilizing buffaloes for cultivation in the Konkan shows that such a development is quite possible and should be profitable to small holders. A fair demand exists for the services of buffalo-bulls kept on the Government farms.

A number of silos have been constructed in the various parts of the presidency in which *juar*, maize, grass and cane tops are stored. The use of mowers and chaff cutters is being demonstrated, and the use of prickly pear as a rough feed for cattle is being widely advocated.

In *Madras*, cattle-breeding operations are controlled by the Deputy Director of Agriculture for Live Stock. It is proposed to improve the local types by cross-breeding with half-breds supplied by the military dairy farm at Bangalore. Arrangements have also been made with the authorities of that farm for breeding and feeding experiments with different cross-bred cattle.

*Assam*. The Upper Shillong herd of cross-bred and Patna cattle numbered 98 head at the close of the year. The attention of Local Boards has been called to the subject of improving the existing breeds of cattle but the response on the part of the cultivator has not so far been encouraging.

The small herd of the Hebbal dairy in *Mysore* has been improved by the disposal of the poor milkers and unpromising

calves and the substitution of better stock. It is proposed to bring the milking standard of the cows up to not less than 2,000 lb. of milk in a lactation period for a start, and to aim at high figures as time goes on.

The dairy herd at *Pusa*, as explained in previous reports, consists of two main herds with their sub-divisions:

(*a*) a pure bred Montgomery herd; and

(*b*) a cross-bred herd obtained by crossing the poorer milking Montgomery cows with Ayrshire bulls.

As a result of strict selection for milk yield, the Montgomery herd, which numbers 244 head at present, is steadily improving. The best cows now yield from 4,300 lb. to 6,500 lb. in a lactation period of ten months. There is a strong demand from Bihar and the Central Provinces for the pedigree bulls which cross well with local cattle.

The cross-bred herd numbers 91 head. The best of the cows yield from 5,900 to 9,700 lb. of milk in a lactation period of ten months or about two times that of their mothers. (Plate II.) The cross-bred cow also comes in calf regularly and the calf can be weaned without difficulty.

As regards quality of milk, the average of a number of bulk samples showed about the same high content of butter fat for the two, *viz.*, 4·6 per cent.

Thus for purely dairying enterprises, until local breeds can be graded up so as to produce a sufficiency of high milk-yielding cows, the readiest means of increasing milk production lies in crossing indigenous animals with imported bulls from pedigree milking herds. The well-known susceptibility of imported stock to rinderpest may in this case be counteracted by " simultaneous " inoculation, but some measures such as the castration of half-bred bulls will require to be insisted on to check the tendencies to perpetuate non-resistant qualities to this disease.

(*b*) ***Sheep-breeding.*** Although there are several recognized difficulties in the way of improving the Indian sheep from both the wool and mutton points of view, they are by no means insurmountable. Thus, while the experiments in progress at Bantanahal in Madras, like those in some of the other provinces, have met with little success, the attempts made in

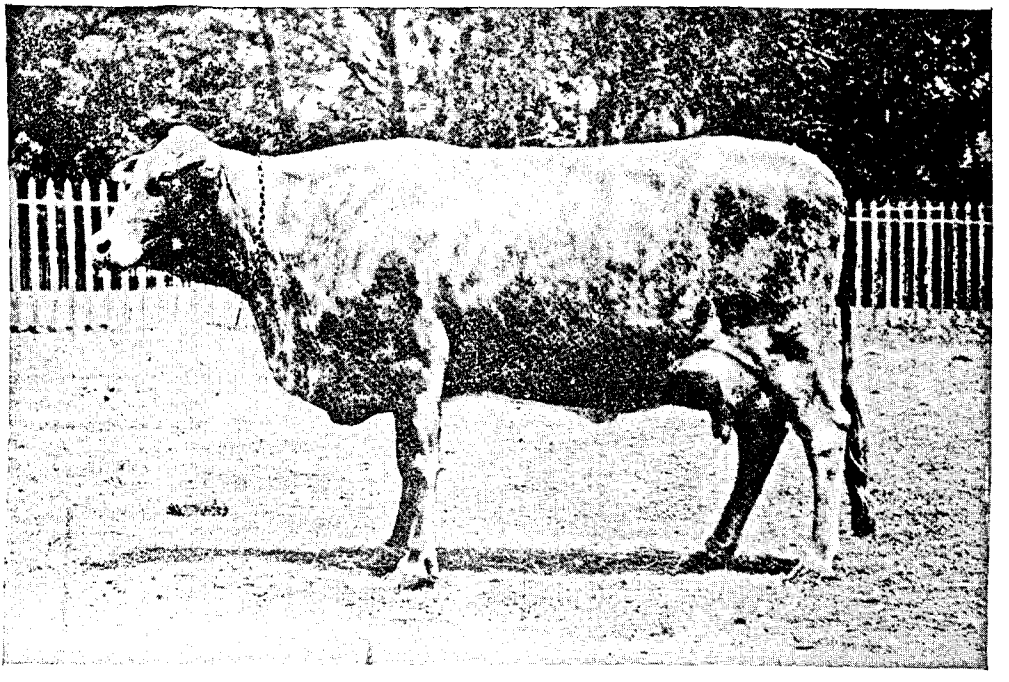

Fig. 1. Cross-bred Cow "Jill" (Bangalore).
Milk yield during the fifth lactation period of 366 days, 13,564 lb.

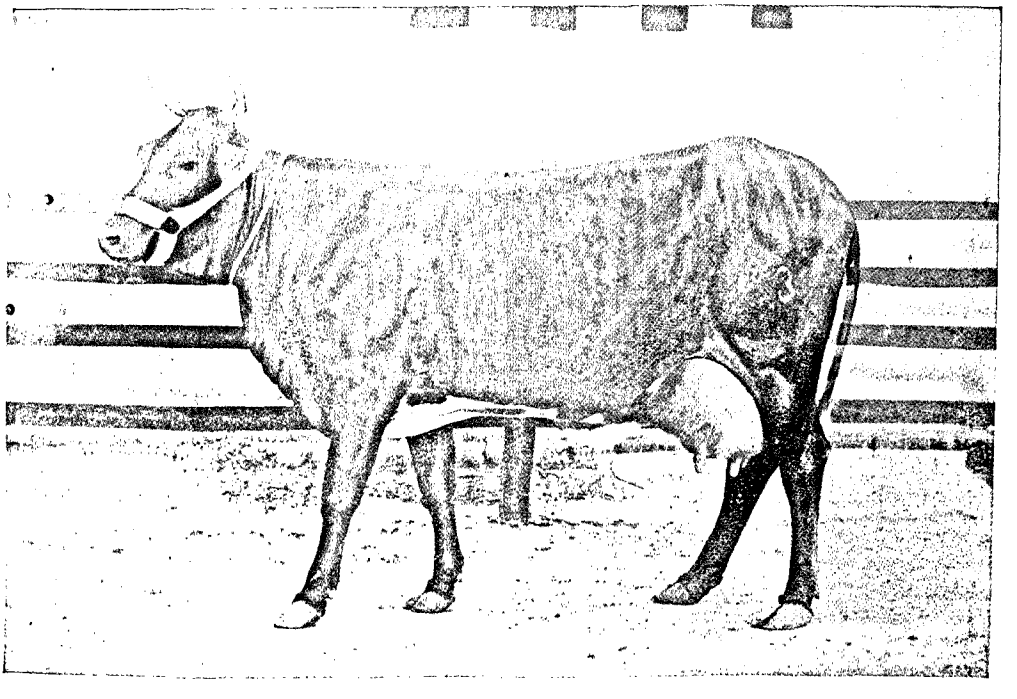

Fig. 2. Cross-bred Ayrshire-Montgomery Cow "Alibi" (Pusa).
Milk yield during the third lactation period of 305 days, 9,726 lb.

the United Provinces, the Punjab and the North-West Frontier Province continue to yield increasingly promising results.

It is now seven years since serious attention was first paid to the subject of sheep-breeding in the *United Provinces*. The main line of experiment consists in crossing the Indian ewe with the Australian Merino. The first cross bears a close resemblance to the sire, but does not show much improvement in carcase. In quality of fleece, however, the half-bred is markedly superior in staple, strength and softness. The yield is greater in quantity and its market value is three to four times that of the country wool. The three-quarter-breds, *i.e.*, the progeny of the half-bred ewes and the Australian Merino, show a still further improvement. The wool is longer in staple, finer, and softer. It has a decided crimp, but it still contains a certain amount of kemp. In the latest cross of lambs bred from the three-quarter-bred ewes by a Merino, still further improvement in the quality and quantity of the wool has been achieved, and it is hoped that, by mating these graded ewes with similarly graded rams, the improvement will remain fixed. The fleeces from the 1919-20 clip fetched as much as R. 1-12-0 per pound. The second series of experiments consists of a mass introduction of half-bred rams into country flocks. At first these were given free to selected shepherds, but on an increased demand they are sold for moderately high prices. Although it is not yet possible to say definitely what the general result has been in several flocks, a considerable improvement on the local stock has been noted. So far the experiments have been conducted with a view to improve the fleece, but it has now been decided to carry out further experiments directed towards an improvement in the carcase. For this purpose, Romney Marsh rams are being imported. At present experimental flocks are maintained at Lucknow, Moradabad, Muttra, Etawah, Kheri and Naini Tal, while schemes for establishing extensive sheep runs in Bundelkhand and in the Benares State are under consideration. One hundred and forty-three half-bred stud rams have been issued to private flocks.

In the *Punjab*, the total number of sheep on the Hissar farm, at the close of the year, was 1,332, valued at Rs. 10,056. The wool of the cross-breds, sold to the Cawnpore Woollen

Mills, realized up to R. 1-4-0 per lb. It is reported that coloured lambs, sold locally and fattened, yielded mutton of the very highest quality equal or superior to the best English or Colonial mutton. Ewes were again allowed to lamb once in the year and all in the spring. Experience shows that, by the adoption of these measures, a large number of deaths among lambs in the Punjab can easily be avoided. One hundred and eight rams and fifty-five ewes were sold during the year for breeding purposes. The demand for these is steadily increasing. Reports from the various districts, where cross-breeding with Merino rams is carried out, are encouraging. The best results can, however, be expected only in those flocks where the Merino rams are used systematically with due regard to the necessity of introducing fresh blood from time to time.

In the *North-West Frontier Province*, there is little to record of the Hazara Merino flock. The experiments with the broad-tail Pusht-i-kuh rams obtained from Mesopotamia are in progress on the agricultural farm at Peshawar. They closely resemble the Hashtnagari of the Peshawar District and breed freely with the latter. They do not however cross with the fat-tail Peshawari breed. In the first cross between the Pusht-i-kuh and Hastnagari breeds marked improvement is noticed in the rate of maturity, in the live and dead weights, and in the quality and weight of the fleece; but grading and selection must be continued. It has been decided to distribute some of the crosses to selected local shepherds.

In *Mysore*, the cross-bred Merino flock established by the agricultural committee at Gottigere was taken over by the Agricultural Department. The wool clip of the Merino crosses has shown considerable increase over that of the local sheep. A first clip of from 2 to 3 lb. of wool of fair quality has been taken from the yearling Merino hybrids, compared with a yield of from 6 to 17 ounces of coarse wool from the adult local ewes. A further increase of wool is looked for when the hybrids reach maturity.

## V. Veterinary Education.

For the training of students in veterinary science, there are colleges provided at Bombay, Madras, Calcutta and

Lahore and schools at Insein and Taunggyi in Burma. The colleges at Bombay, Madras and Calcutta continued to give a 3-year diploma course in English, while that at Lahore held a similar diploma course in the vernacular. Proposals for a revised course for the Lahore college, involving four years' instruction in English, have been approved by Government, and will be brought into force as soon as the necessary arrangements have been made. Meanwhile, the four-years' vernacular course, as at present conducted, has been definitely abandoned. The total number of students who passed the final examinations of the colleges during the year was 153 as against 142 of the preceding year. (Appendix V, p. 125.)

The scheme for establishing a veterinary college for the United Provinces, which has been delayed owing to the war and other reasons, is now receiving the attention of Government. It is hoped that building operations will shortly be started at Lucknow, where a site has already been selected.

For post-graduate training, a revised course of instruction has been drawn up for the Lahore veterinary college and will be instituted in due course, while proposals for the institution of similar training at the Madras veterinary college and in the veterinary research laboratory at Nagpur are under consideration.

The veterinary schools at Insein and Taunggyi give vernacular courses of three years and a year and a half respectively. Although these schools are attracting candidates in larger numbers, they do not fully meet the requirements of Burma, and provision will shortly have to be made for higher veterinary education with a view to the training of Deputy Superintendents in the province.

The United Provinces Veterinary Medical Society continued to do good work and a well attended and successful meeting of its members was held at Agra. The Bombay Veterinary Department held two meetings of the staff at which papers on professional subjects were read and discussed. These meetings are organized with a view to encourage a keener interest of the members of the department in their professional duties. The Madras department published a bi-monthly magazine entitled

the *Madras Veterinary Journal* which met with considerable success.

For educating the public in veterinary matters, leaflets dealing with prevention and treatment of cattle diseases were freely distributed and lectures on animal diseases, cattle-breeding, etc., given to cultivators and stock-owners congregated at fairs and shows.

## VI. Veterinary Research.

As mentioned in the previous reviews, depletion of staff and increased routine and administrative duties have greatly curtailed opportunities for research work, the greater part of which was carried out at the Imperial Bacteriological Laboratory, Muktesar, and related to the following subjects :—

*Rinderpest and Hæmorrhagic Septicæmia.* The experiments in progress during the year 1918-19 regarding infectivity of hides of animals which died of the diseases were continued during the year under report.

*Johne's disease.* A herd infected with Johne's disease in Bettiah Raj in Bihar was submitted to a test with avian tuberculin. As it was impossible to obtain permission to kill any of the reacting animals, the value of the test could not be determined.

*Tuberculosis.* The inoculation experiments foreshadowed in last year's report have been completed and an account of them will be published shortly.

*Bovine lymphangitis.* With material received from the Madras Presidency experimental work has been carried out and the causal organism has been isolated.

*Surra.* An experiment was initiated at the Muktesar laboratory, on the recommendation of the Surra Committee, to ascertain the effects on different animals of the inoculation of strains of the *Trypanosoma evansi* derived from other species. Experiments in curative drug treatment were also carried out. Detailed reports by Mr. H. E. Cross, Camel Specialist, on the course that surra runs in camels, when naturally contracted and when artificially inoculated, and on the course that camel surra runs in ponies, buffaloes and other animals, are under

publication. Further experiments with tartar emetic and other drugs in connection with the treatment of surra are being carried out by Mr. Cross. The Imperial Pathological Entomologist continued his work on surra and carried out a fly survey in the Punjab and the North-West Frontier Province.

In the United Provinces, the research and experimental station at Badshahbag continued to fulfil a useful purpose in affording opportunity to the staff for observation and study of disease and methods of research. Some inquiries have been carried on in regard to cattle tuberculosis, spirochetosis in fowls and *kamri*. Investigations regarding the most economical and effective form of drug treatment for the numerous internal and external parasites of sheep and cattle, as well as the prophylactic and curative effects of various vaccines, have also been carried on.

## CHAPTER IX.

## PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

***Imperial.*** The Imperial Department of Agriculture in India issued nine Memoirs, six Bulletins, one Indigo Publication, and three pamphlets during the year, while 32 publications were in the press at the close of the year.

The proceedings of four conferences, *viz.*, the Eleventh Meeting of the Board of Agriculture in India, the Second Meeting of Mycological Workers, the First Meeting of Agricultural Chemists and Bacteriologists, and the First Meeting of Veterinary Officers, held in 1919, were also brought out during the year. The Report of the Proceedings of the Third Entomological Meeting, an octavo volume of 1,138 pages of print and 182 plates, was still in the press on the 30th June, 1920.

The issue of the *Agricultural Journal of India* every two months, instead of every quarter, has further stimulated its circulation.

***Provincial.*** The *United Provinces* Department of Agriculture issued a pamphlet on trench-making for sugarcanes and a leaflet on the advantages of sowing maize with *nai*. The two monthly vernacular journals, *Mufid-ul-Mazarin* and *Kisanupkarak*, mentioned in last year's report, were also regularly issued. These journals are performing a very useful function in spreading up-to-date information on agricultural matters among the zemindars and others interested in agriculture.

In *Bombay*, 11 bulletins on the sugarcane borer, fruit culture, fodder, rice, etc., and seven leaflets (with vernacular versions) on various subjects were issued by the department. The *Poona Agricultural College Magazine* and the Calendar of the Agricultural College continued to issue.

In *Madras*, 3 bulletins and 10 leaflets were issued in the vernacular. The publication of the Departmental Year Book in English was continued, while the Agricultural Calendar

was issued under the new title of "Villagers' Calendar." A Calendar for the Agricultural College and Research Institute, Coimbatore, was also published.

In the *Central Provinces*, Mr. Clouston's book entitled "Story of Rai Sahib Kaluram Kurmi" was issued and widely distributed. A bulletin on the Sindewahi furnace for *gur* making and a leaflet on groundnut were issued during the year, and two bulletins on *Citrus* pests were in the press at the close of the year.

The *Burma* Department of Agriculture issued 2 leaflets during the year. A revised bulletin on the "Cultivation of Para Rubber," a leaflet on "Cambodia Cotton" and a report on the results of investigations into the "Gwabo" pest were in the press. The issue of the Burma Agricultural Calendar discontinued in 1916-17, was revived during the year.

In *Assam*, 2 leaflets on the cultivation of pulses were issued. A note on fruit culture written by the Hon'ble Mr. C. H. Holder and translated into Khasi was circulated among the cultivators of the Khasi and Jaintia Hills.

A complete list of agricultural publications in India issued during the year under report is given as Appendix VI, pages 126—140.

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## CHAPTER X.

## EXPENDITURE OF THE AGRICULTURAL DEPARTMENTS.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year ending the 31st March, 1920, was Rs. 6,59,343 as against Rs. 6,06,640 during the previous year. The details are given below :—

| | Rs. |
|---|---|
| General expenditure on the Institute (including the office of the Agricultural Adviser and Director) | 2,61,236 |
| Chemical Section | 39,856 |
| Mycological Section | 45,983 |
| Entomological Section | 54,089 |
| Pathological Entomological Section | 31,259 |
| Bacteriological Section | 39,077 |
| Botanical Section | 45,261 |
| Agricultural Section | 87,381 |
| Indigo Research Section | 51,838 |
| Protozoological Section | 3,363 |
| TOTAL | 6,59,343 |

A sum of Rs. 15,000 was paid as a grant-in-aid to the Indian Tea Association.

The principal items of expenditure under the annual grant of Rs. 10,000 placed at the disposal of the Agricultural Adviser to the Government of India for special agricultural experiments were as follows :—

| | Rs. |
|---|---|
| For investigation of anti-scorbutic and anti-beriberi properties of sun-dried vegetables | 2,000 |
| Cost of fencing materials | 993 |
| Entertainment of visitors during motor tractor demonstrations | 747 |
| Pebrine experiments | 246 |
| Cost of oil for surra experiments | 500 |
| Apparatus and appliances for the Mycological Section at Pusa | 1,409 |

| | |
|---|---|
| Experimental cotton cultivation by the Imperial Cotton Specialist, Poona | 1,000 |
| Mosquito experiments at Pusa | 316 |
| Pay of a Veterinary Assistant | 541 |

The expenditure incurred on the working of the Imperial Bacteriological Laboratory at Muktesar during the period was Rs. 5,00,510 as against Rs. 4,37,712 in the previous year. The principal items were as follows :—

| | Rs. |
|---|---|
| Salaries and travelling allowances of officers and staff | 1,16,908 |
| Feed and keep of animals | 2,40,100 |
| Cost of chemicals and apparatus | 21,584 |
| Purchase of animals | 58,814 |
| Miscellaneous expenditure | 63,104 |
| TOTAL | 5,00,510 |

The total expenditure which the Provincial Departments of Agriculture incurred during the year amounted to Rs. 71,71,025 as against Rs. 69,07,830 during 1918-19. The details are given below :—

| | Rs. |
|---|---|
| Bengal | 8,38,671 |
| Bihar and Orissa | 3,88,872 |
| United Provinces | 9,90,814 |
| Punjab | 11,18,512* |
| Bombay | 13,43,892 |
| Madras | 13,16,837 |
| Central Provinces | 5,10,020 |
| Burma | 2,96,723† |
| Assam | 3,08,066 |
| North-West Frontier Province | 40,019‡ |
| Baluchistan | 18,599 |
| TOTAL | 71,71,025 |

*Excluding Rs. 1,83,836 on account of buildings and Rs. 3,946 on account of printing charges.

†Excluding Rs. 14,362 representing contributions to botanical and other public gardens.

‡Excluding agricultural scholarships.

## APPENDIX I.

*List of Agricultural Stations in British India in 1919-20.*

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| | Pusa, Bihar | 550 | Overseer | Imperial Agriculturist, Agricultural Research Institute, Pusa. | Under the Imperial Department of Agriculture. |
| Bombay | Surat | 291 | Superintendent | Deputy Director of Agriculture, Gujarat, Surat. | |
| | Amalsad | 5 | Overseer | Ditto | |
| | Nadiad | 44 | Ditto | Ditto | |
| | Broach | 27 | Ditto | Ditto | |
| | Dohad | 57 | Superintendent | Ditto | |
| | Dhulia | 28 | Ditto | Deputy Director of Agriculture, Central Division, Poona. | |
| | Jalgaon | 214 | Ditto | Ditto | |
| | Kopargaon | 109 | Ditto | Ditto | Fodder farm. |
| | Kopargaon | 3 | Ditto | Ditto | Sugarcane station. |
| | Dharwar | 134 | Ditto | Deputy Director of Agriculture, Southern Division, Dharwar. | |
| | Gadag | 50 | Overseer | Ditto | |
| | Gokak Canal | 62 | Superintendent | Ditto | |

*List of Agricultural Stations in British India in 1919-20*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bombay—*concld.* | Tegur | 248 | Fieldman | Deputy Director of Agriculture for Animal Breeding. | Cattle-breeding farms. |
| | Chharodi | 2,700 | Manager | Ditto | |
| | Bankapur | 112 | Ditto | Ditto | |
| | Alibag | 38 | Superintendent | Deputy Director of Agriculture, Konkan, Ratnagiri. | |
| | Ratnagiri | 22 | Ditto | Ditto | |
| | Kumta | 19 | Ditto | Ditto | |
| | Mirpurkhas | 200 | Ditto | Deputy Director of Agriculture, Sind, Mirpurkhas. | Seed farm. |
| | Mirpurkhas | 60 | Ditto | Ditto | |
| | Sukkur | 30 | Ditto | Ditto | |
| | Larkana | 65 | Ditto | Ditto | |
| | Landhi | 24 | Ditto | Ditto | |
| | Jacobabad | 300 | Ditto | Ditto | |
| | Ganeshkhind, Kirkee | 80 | Ditto | Economic Botanist, Poona | Agricultural and botanical station. |
| | Poona | 185 | Ditto | Professor of Agriculture, Poona Agricultural College. | Agricultural College farm |

| | | | | | |
|---|---|---|---|---|---|
| Madras | Kirkee | 362 | Manager | Ditto | Agricultural College dairy. |
| | Manjri | 62 | Superintendent | Ditto | Sugarcane experimental station. |
| | Coimbatore | 450 | Manager | Principal, Agricultural College and Research Institute, and Superintendent, Central Farm, Coimbatore. | Central farm attached to the Agricultural College. |
| | Samalkota | 57 | Ditto | Deputy Director of Agriculture, I Circle, Anakapalle. | |
| | Anakapalle | 40 | Ditto | Ditto | |
| | Hagari | 224 | Ditto | Deputy Director of Agriculture, III Circle, Bellary. | |
| | Bantanahal | 819 | Ditto | Ditto | Sheep and seed farm. |
| | Sirvel | 44 | Ditto | Ditto | |
| | Nandyal | 88 | Ditto | Ditto | |
| | Palur | 52 | Ditto | Deputy Director of Agriculture, IV Circle, St. Thomas' Mount. | |
| | Gudiyattam | 18 | Ditto | Assistant Director of Agriculture, IV Circle, Vellore. | Demonstration farm. |
| | Koilpatti | 140 | Ditto | Deputy Director of Agriculture, V and VII Circles, Coimbatore. | |
| | Manganallur | 92 | Ditto | Ditto | |
| | Kasargod | 55 | Ditto | Ditto | West Coast coconut station. |

*List of Agricultural Stations in British India in 1910-20*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Madras—*concld.* | Anamalai | 40 | Manager | Deputy Director of Agriculture, V and VII Circles, Coimbatore. | Cotton farm. |
| | Taliparamba | 85 | Ditto | Assistant Director, VII Circle, Tellicherry. | |
| | Tenmalai (Travancore) | 20 | Ditto | Deputy Director of Agriculture, Planting Districts, Coimbatore. | Rubber stations. |
| | Mooply (Cochin) | 20 | Ditto | | |
| | Sidapur (Coorg) | 19 | Ditto | | Coffee stations. |
| | Peermade (Travancore) | 20 | Ditto | | |
| | Chintaladevi | 850 | Ditto | Deputy Director of Agriculture for Live Stock, Madras. | Cattle farm. |
| | Dacca | 354 | Superintendent | Deputy Director of Agriculture, Eastern Circle, Dacca. | |
| | Mymensingh | ... | Ditto | | |
| | Comilla | ... | Ditto | | |
| | Rajshahi | 63 | Ditto | Deputy Director of Agriculture, Northern Circle. | |
| | Rangpur | 333 | Ditto | | Cattle farm. |
| | Rangpur | 19 | Ditto | | Demonstration farm. |
| | Burirhat (Rangpur) | 52 | Ditto | | Tobacco farm. |
| | Bogra | ... | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| Bengal | Chinsurah | 210 | Ditto | Deputy Director of Agriculture, Western Circle, Calcutta. | |
| | Burdwan | 32 | Ditto | | Private farm under the supervision of the Agricultural Department. |
| | Kalimpong | 76 | Manager | ..... | Private domonstration farm managed by St. Andrew's Colonial Homes, with a subsidy from the Bengal Agricultural Department. |
| | Berhampur | ... | Superintendent of Sericulture. | ..... | Sericultural research stations. |
| | Kurseong | ... | | | |
| | Kalimpong | ... | | | |
| Bihar and Orissa | Sabour | 190 | Superintendent | Professor of Agriculture | Home farm attached to the Agricultural College, Sabour. |
| | Dumraon | 30 | Ditto | Deputy Director of Agriculture, Patna Circle, Bankipore. | Private farm under the supervision of the Agricultural Department. |
| | Ranchi (Kanke) | 140 | Ditto | Director of Agriculture, Bihar and Orissa. | |
| | Neterhat | 193 | Inspector | Ditto | Potato farm. |
| | Purulia | 52 | Ditto | Assistant Director of Agriculture, Chota Nagpur Circle. | Experimental and seed farm. |
| | Ramgarh | 43 | Ditto | Ditto | Ditto |
| | Sambalpur | 32 | Ditto | Ditto | Ditto |
| | Cuttack | 150 | Superintendent | Deputy Director of Agriculture, Orissa Circle, Cuttack. | |
| | Khurda | 31 | Inspector | Ditto | Experimental and seed farm. |

*List of Agricultural Stations in British India in 1919-20*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bihar and Orissa—*concld.* | Balasore | 80 | Inspector | Deputy Director of Agriculture, Orissa Circle, Cuttack. | Experimental and seed farm. |
| | Angul | 25 | Overseer | Deputy Commissioner, Angul. | Private demonstration farm under the supervision of the Deputy Director of Agriculture, Orissa Circle. |
| | Sipaya | 379 | Superintendent | ..... | Cattle-breeding farm and sugarcane station. |
| United Provinces | Cawnpore | 58 | Inspector | Deputy Director of Agriculture, Central Circle, Cawnpore. | |
| | Kalianpur | | Fieldman | | Seed farm. |
| | Orai | 87 | Inspector | | |
| | Altara | 171 | Divisional Superintendent of Agriculture. | | |
| | Etawah | 50 | Inspector | | Demonstration farm. |
| | Hardoi | 40 | Ditto | | |
| | Mainpuri | 52 | Ditto | | |
| | Partabgarh | 90 | Superintendent | Deputy Director of Agriculture, Eastern Circle, Partabgarh | |
| | Naugawan | 400 | Ditto | | |
| | Fyzabad | 206 | Inspector | | Seed farm. |
| | Benares | 78 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| | Aligarh | 88 | Inspector | Deputy Director of Agriculture, Western Circle, Aligarh. | |
| | Nawabganj (Bareilly) | 110 | Overseer | | |
| | Muzaffarnagar | 109 | Superintendent | | |
| | Muttra | 56 | Overseer | | |
| | Agra | 109 | Ditto | | |
| | Saharanpur | 39 | Inspector | | |
| | Bulandshahr | 25 | Ditto | | |
| | Aligarh(Kalai) | 166 | Overseer | | Seed farm. |
| | Gorakhpur | 112 | Ditto | Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur. | |
| | Bahraich | 20 | Ditto | | Demonstration farm. |
| | Lyallpur | 430 | Manager | Deputy Director of Agriculture, 3rd Circle. | |
| | Montgomery | 250 | Extra Assistant Director of Agriculture | Professor of Agriculture, Punjab Agricultural College. | Mainly a seed farm. |
| | Gurdaspur | 161 | Manager | Deputy Director of Agriculture, 1st Circle. | |
| Punjab | Sargodha | 157 | Ditto | Ditto | Seed farms. |
| | Chilianwalla | 250 | (Given to tenants) | Ditto | |
| | Hansi | 282 | Manager | Deputy Director of Agriculture, 2nd Circle. | |
| | Kahuta | 558 | Extra Assistant Director of Agriculture. | Agricultural Chemist, Punjab | For reclamation of saline soils. |

*List of Agricultural Stations in British India in 1919-20*—contd.

| Name of Province | Name of the Agricultural Station. | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Burma | Mandalay | 430 | Superintendent | Deputy Director of Agriculture, Northern Circle, Mandalay. | |
| | Padu | 29 | Overseer | Ditto | |
| | Bugyi and Nagu Plots | 4 | Ditto | Ditto | |
| | Hopin | 33 | Ditto | Ditto | |
| | Yawnghwe | 36 | Ditto | Ditto | |
| | Hsum Hsai | 15 | Ditto | Ditto | |
| | Hmawbi | 432 | Superintendent | Deputy Director of Agriculture, Southern Circle, Insein. | |
| | Tatkon | 45 | Ditto | Ditto | |
| | Nyaunglebin (Pegu) | 15 | Overseer | Ditto | |
| | Yodashe (Toungoo) | 27 | Ditto | Ditto | |
| | Zigon (Tharrawaddy) | 20 | Ditto | Ditto | |
| | Thilawa (Hanthawaddy) | 19 | Ditto | Ditto | |
| | Taungtha (Myingyan) | 16 | Ditto | Ditto | |
| | Pakokku | 10 | Ditto | Ditto | |
| | Pwinbyu (Minbu) | 12 | Ditto | Ditto | |
| | Allanmyo (Thayetmyo) | 27 | Ditto | Ditto] | |

| | | | | | |
|---|---|---|---|---|---|
| Central Provinces | Nagpur | 268 | Superintendent | Principal, Agricultural College, Nagpur. | College farm. |
| | Akola | 271 | Ditto | Deputy Director of Agriculture, Western Circle, Nagpur. | |
| | Borgaon | 368 | Ditto | Ditto | |
| | Yeotmal | 106 | Ditto | Ditto | |
| | Khandwa | 177 | Ditto | Ditto | |
| | Basim | 109 | Ditto | Ditto | |
| | Sindewahi | 197 | Ditto | Deputy Director of Agriculture, Southern Circle, Nagpur. | |
| | Chandkhuri | 333 | Ditto | Ditto | |
| | Raipur | 229 | Ditto | Ditto | |
| | Tharsa | 116 | Ditto | Ditto | |
| | Wara—seoni | 63 | Ditto | Ditto | |
| | Bilaspur | 253 | Ditto | Ditto | |
| | Drug | 281 | Ditto | Ditto | |
| | Telinkheri | 1,000 | Ditto | Ditto | Dairy farm. |
| | Powarkhera (Hoshangabad). | 528 | Ditto | Deputy Director of Agriculture, Northern Circle, Jubbulpore. | |
| | Adhartal (Jubbulpore) | 637 | Ditto | Ditto | |
| | Chhindwara | 69 | Ditto | Ditto | |
| | Betul | 161 | Ditto | Ditto | |

*List of Agricultural Stations in British India during 1919-20*—concld.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Central Provinces—*concld.* | Seoni | 164 | Superintendent | Deputy Director of Agriculture, Northern Circle, Jubbulpore. | |
| | Saugor | 161 | Ditto | Ditto | |
| | Damoh | 152 | Ditto | Ditto | |
| Assam | Jorhat | 59 | Manager | Agricultural Chemist, Assam. | |
| | Kamrup | 800 | Ditto | Ditto | Sugarcane experiment station. |
| | Upper-Shillong | 367 | Ditto | Deputy Director of Agriculture, Surma Valley and Hill Districts. | |
| | Karimganj | 80 | Ditto | | |
| | Shillong | 63 | Superintendent | | Fruit Experiment station. |
| North-West Frontier Province. | Tarnab (Peshawar) | 200 | Manager | Agricultural Officer, North-West Frontier Province, Peshawar. | |
| | Haripur | 20 | Ditto | Ditto | |

## APPENDIX II.

*List of Agricultural Colleges and Schools in British India during 1919-20.*

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | *(a) Post-graduate Training Institution.* | | | |
| ... | Agricultural College, Pusa | Pusa, Bihar | 8 | Besides regular courses in Botany, Mycology, Agricultural Chemistry, Agricultural Bacteriology, Entomology, and General Agriculture, short courses in Sericulture and Lac-culture are also given. There were 5 students undergoing training in Sericulture during 1919-20. | |
| | | *(b) Provincial Agricultural Colleges.* | | | |
| Bombay | Poona Agricultural College | Poona | 203 | Affiliated to the University of Bombay who confer the Degree of B.Ag. on passed students. The course is for 3 years. Students before admission must have passed the Previous Examination of the Bombay University or Intermediate Examination in Arts or in Science of all other Indian Universities, or of the London University. A short course in agriculture is also given to farmers' sons | |

*List of Agricultural Colleges and Schools in British India during 1919-20*—contd.

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | | | *(b) Provincial Agricultural Colleges**—concld. | |
| | | | | who know English but who are not qualified to take the University course in agriculture. This course lasts for 1 year. | |
| Madras | Agricultural College, Coimbatore. | Coimbatore | 112 | Two courses of instruction are given :—<br>(1) The first course (2 years) for Certificate of Proficiency in practical agriculture, and<br>(2) The second course (18 months in continuation of the 1st course) for the Diploma or Licentiate in Agriculture. | |
| Central Provinces | Agricultural College, Nagpur. | Nagpur | 67 | The courses of instruction given are :—<br>In Agriculture—<br>(1) Four years' course for the Licentiate of Agriculture, and<br>(2) Two years' Diploma course for the sons of malguzars and substantial cultivators who intend to manage their own lands, and to whom | |

| | | | | |
|---|---|---|---|---|
| | | | | a full scientific course is unnecessary.<br>In Dairying—<br>(1) The Dairy Diploma course of two and a half years, and<br>(2) The Dairy short course of six months. |
| Bihar and Orissa . | Agricultural College, Sabour. | Sabour . . . (near Bhagalpur) | 68 | The course of instruction given is one of two years Certificate. Besides this, short season courses (*Bhadoi* and *Rabi*) are given. Nine students attended these courses during 1919-20. |
| United Provinces. | Agricultural College, Cawnpore. | Cawnpore . . | 100 | Two courses of instruction are given :—<br>(1) Diploma (L.Ag.) course of 4 years, and<br>(2) Two years' or Vernacular course. |
| Punjab . . | Punjab Agricultural College. | Lyallpur . . | 132 | Affiliated to the Punjab University. Two courses of instruction are given :—<br>(1) Two years' course for Leaving Certificate ; and<br>(2) Four years' course for the Degree of B.Sc. in Agriculture. Besides, there are : a Vernacular Class which lasts for 1 year only, a Teachers' class which lasts for one year and a Rural Economy class which lasts for a shorter period. |

*List of Agricultural Colleges and Schools in British India during 1919-20*—concld.

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | (c) *Agricultural Middle Schools.* | | | |
| Central Provinces | Agricultural Middle School, Powarkhera. | Powarkhera Experimental Farm, District Hoshangabad | 16 | 2 years' course. | |
| Do. | Agricultural Middle School, Chandkhuri. | Chandkhuri Experimental Farm, District Raipur. | 27 | 2 years' course. | |
| | | (d) *Vernacular Agricultural Schools.* | | | |
| Bombay . . | Vernacular Agricultural School, Loni (in Marathi). | Loni, District Poona. | 43 | 2 years' course. | |
| Do. . . | Vernacular Agricultural School, Devi-hosur (in Kanarese). | Devi-hosur, District Dharwar. | 27 | 2 years' course. | |
| Do. . . | Vernacular Agricultural School, Veshvi, Kolaba (in Marathi). | Veshvi, District Kolaba. | 25 | 2 years' course. | |
| Do. . . | Vernacular Agricultural School, Jambul (in Marathi). | Jambul, District Thana. | 25 | 2 years' course. | |
| Do. . . | Vernacular Agricultural School, Godhra (in Gujarati). | Godhra, District Panchmahals. | 9 | 2 years' course. | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Do. | . . | Vernacular Agricultural School, Mirpurkhas (in Sindhi). | Mirpurkhas, District Thar and Parkar, Sind. | 5 | 1 year's course. | |
| Bengal | . . | Vernacular Agricultural School, Dacca. | Manipur, District Dacca. | 30 | | |
| Do. | . . | Vernacular Agricultural School, Amarpur. | Amarpur, District Burdwan. | | | |
| Do. | . . | Vernacular Agricultural School, Durgapur. | Durgapur, District Chittagong. | | | |

## APPENDIX III.

### *Operations of Non-Credit Agricultural Co-operative Societies in British India during 1919-20.*

The two tables below include Agricultural Societies for—

A. 1. *Purchase, and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghee*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

*Operations of Non-Credit Agricultural Co-operative Societies in British India during 1919-20*—contd.

(A) *Purchase, Sale and Production.*

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working Capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bombay | Purchase and Purchase and Sale. | 26 | 1,305 | 52,206 | 7,463 | 65,439 | +3,695 | |
| | Production | 14 | 416 | ... | ... | 1,256 | +768 | |
| | Production and Sale | 40 | 4,768 | 9,16,054 | 17,28,064 | 1,46,515 | +14,729 | |
| | Others | 18 | 738 | 5,316 | 3,181 | 20,010 | +1,901 | |
| | TOTAL | 98 | 7,227 | 9,73,576 | 17,38,708 | 2,33,220 | +21,093 | |
| Madras | Purchase and Purchase and Sale | 58 | 3,339 | 1,97,987 | 24,233 | 2,80,433 | +6,140 | |
| | Production and Sale | 2 | 23 | ... | ... | 709 | ... | |
| | Others | 2 | 158 | ... | ... | 852 | —10 | |
| | TOTAL | 62 | 3,520 | 1,97,987 | 24,233 | 2,81,994 | +6,130 | |
| Bengal | Purchase and Purchase and Sale. | 7 | 3,645 | 2,39,146 | 57,900 | 79,010 | +9,610 | |
| | Production | 5 | 833 | ... | ... | 9,957 | —893 | |
| | Production and Sale | 44 | 4,758 | 8,41,495 | 3,44,478 | 6,15,198 | +1,75,642 | |
| | TOTAL | 56 | 9,236 | 10,80,641 | 4,02,378 | 7,04,165 | +1,84,359 | |

## *Operations of Non-Credit Agricultural Co-operative Societies in British India during 1919-20*—concld.

### (A) *Purchase, Sale and Production*—concld.

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working Capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bihar and Orissa | Purchase and Purchase and Sale. | 3 | 183 | 3,058 | 4,325 | 9,978 | —411 | |
| | Production and Sale | 16 | 172 | 112 | 15,372 | 18,975 | +5,610 | |
| | TOTAL | 19 | 355 | 3,170 | 19,697 | 28,953 | +5,199 | |
| United Provinces | Purchase and Purchase and Sale. | 1 | 70 | 4,751 | 3,251 | 6,870 | +141 | |
| | Production and Sale | 8 | 327 | ... | 10,217 | 28,302 | +1,473 | |
| | TOTAL | 9 | 397 | 4,751 | 13,468 | 35,172 | +1,614 | |
| Punjab | Purchase and Purchase and Sale. | 144 | 1,404+1601* | 5,18,025 | 2,46,740 | 3,03,264 | +13,352 | * Societies |
| | Production and Sale | 37 | 843 | 9,131 | 1,172 | 65,655 | +1,173 | |
| | Others | 36 | 1,754 | ... | ... | 317 | +277 | |
| | TOTAL | 217 | 4,001+1,601* | 5,27,156 | 2,47,912 | 3,69,236 | +14,802 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Burma | Purchase and Purchase and Sale. | 16 | 904 | 8,140 | ... | 19,525 | +1,097 |
| | Production and Sale | 53 | 3,604 | 63,415 | 14,126 | 71,817 | +11,038 |
| | Others | 33 | 763 | ... | ... | ... | ... |
| | TOTAL | 102 | 5,271 | 71,555 | 14,126 | 91,342 | +12,135 |
| Central Provinces and Berar. | Purchase and Purchase and Sale. | 31 | 2,997 | 3,33,005 | ... | 1,86,878 | +15,769 |
| | Production | 3 | 69 | ... | ... | 16,276 | +647 |
| | TOTAL | 34 | 3,066 | 3,33,005 | ... | 2,03,154 | +16,416 |

## (B) *Cattle Insurance.*

| PROVINCE | Number of societies | Amount of risk insured | Premia collected during the year | Supplementary contribution collected | NUMBER OF ANIMALS | | Claims paid | Cost of management | Funds in hand at end of year | Amount of risk re-insured | Amount of premia paid for re-insurance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Insured | Lost | | | | | |
| | | Rs. | Rs. | Rs. | | | Rs. | Rs. | Rs. | Rs. | Rs. |
| Bombay | 4 | 2,490 | 124 | ... | 39 | 3 | 67 | 24 | 470 | ... | ... |
| Punjab | 22 | 49,010 | 1,993 | ... | 587 | 6 | 347 | 70 | 1,955 | 14,902 | 649 |
| Burma | 381 | 1,69,767 | 5,446 | ... | 4,619 | 166 | 3,176 | 351 | 23,354 | 99,780 | 2,548 |
| | 1* | 99,780 | 2,715 | ... | 4,619 | 166 | 1,973 | 518 | 15,614 | ... | ... |

* Central Re-insurance Society.

## APPENDIX IV.

*Table showing the working of the Provincial Civil Veterinary Departments during 1919-20.*

| Province | No. of Superior staff | | Research | Dispensaries and Hospitals | | | District staff and work | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Imperial Service Officers | Provincial Service Officers | | No. of Hospitals and Dispensaries | No. of Veterinary Assistants employed | No. of cases treated and castrations performed | No. of Inspectors | No. of Veterinary Assistants | No. of outbreaks in which inoculation was undertaken | Cases treated and castrations performed | Deaths uninoculated | Inoculations | Deaths after inoculation |
| Bombay | 3 | 10 | Infectious Lymphangitis of cattle, examination of specimens, etc. | 65 | 65 | 1,51,202 | 5 | 65 | 256 | 16,086 | 4,440 | 31,223 | 217 |
| Madras | 3 | 4 | Examination of specimens, etc. | 52 | 52 | 66,463 | 15 | 43 | 698 | 38,423 | 12,959 | 90,773 | 115 |
| Bengal | 2 | 7 | Do. do. | 35 | 36 | 47,910 | 6 | 77 | 569 | 58,761 | 6,557 | 85,813 | 385 |
| Bihar and Orissa | 2 | 1 | Do. do. | 24 | 23 | 38,343 | 10 | 76 | 436 | 74,508 | 3,258 | 54,913 | 236 |
| United Provinces | 2 | 3 | Cattle tuberculosis, spirochetosis in fowls, Kamri, etc. | 95 | 95 | 1,25,919 | 20 | 121 | 570 | 63,069 | 9,834 | 53,389 | 127 |
| Punjab | 10 | 5 | Examination of specimens, etc. | 138 | 138 | 4,49,378 | 18 | 154 | 1,131 | 2,34,689 | 11,443 | 1,86,552 | 154 |
| Burma | 1 | 9 | Do. do. | 1 | 1 | 2,184 | 25 | 189 | 456 | 92,798 | 4,822 | 55,628 | 363 |
| Central Provinces | 2 | 3 | Filariasis in equinos, Trypanosomiasis in bovines, etc. | 81 | 81 | 2,09,753 | 16 | 98 | 920 | 1,73,591 | 9,069 | 82,044 | 218 |
| Assam | 1 | 1 | Examination of specimens, etc. | 3 | 3 | 4,152 | 3 | 40 | 383 | 59,182 | 6,168 | 32,172 | 284 |
| North-West Frontier Province | ... | ... | Do. do. | 20 | 19 | 50,519 | 5 | 19 | 96 | 27,986 | 1,322 | 32,085 | 14 |
| Sind | | 1 | Do. do. | 15 | 15 | 22,393 | ... | 15 | 7 | 4,754 | 199 | 1,672 | 9 |
| Baluchistan | 1 | | | 6 | 5 | 13,261 | 1 | 5 | 28 | 3,541 | 590 | 2,907 | 23 |
| Rajputana | | | | 2 | 3 | 3,020 | ... | 3 | 1 | 554 | 5 | 624 | 1 |
| Total for 1919-20 | 27 | 44 | | 537 | 536 | 11,84,497 | 124 | 905 | 5,551 | 8,47,942 | 70,663 | 7,09,795 | 2,476 |
| Total for 1918-19 | 22 | 34 | | 503 | 500 | 9,96,044 | 101 | 776 | 5,447 | 6,07,277 | 79,186 | 7,59,803 | 2,774 |

## APPENDIX V.

*Table showing the details as to Students of Veterinary Colleges and Schools in India during 1919-20*

| Veterinary College or School | Course of instruction | Number of students | | | | | | Students admitted during the year, classed by educational qualifications | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Admitted during the year | | Passed final examination during the year | Failed to pass final examination | Remaining under instruction at end of the year | | Matriculates, school finals or with higher qualifications | Knowing some English but not matriculates | Knowing no English or very little English |
| | | Scholarship-holders | Others | | | In ordinary course | Instruction prolonged by reason of failure to pass | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Bombay Veterinary College | 3 years' English course | 24 | 12 | 21 | 7 | 41 | 34 | 17 | 19 | |
| Madras " " | " " " | 36 | 1 | 19 | 12 | 44 | 18 | 36 | ... | |
| Bengal " " | " " " | 36 | 18 | 32 | 19 | 79 | 26 | 21 | 33 | |
| Punjab " " | 3 years' Vernacular course | 12 | 44 | 60 | 6 | 125 | 35 | 1 | 33 | |
| | 4 " " * | 5 | 20 | 21 | ... | ... | ... | ... | ... | |
| Burma— | | | | | | | | | | |
| Insein School | 3 years' Vernacular course. | 11 | ... | 6 | ... | 45 | 5 | ... | ... | |
| Taunggyi " | 1½ " " | 4 | 3 | 6 | ... | 7 | ... | ... | ... | |

*In abeyance since October 1919; students absorbed in the 3 years' course.

## APPENDIX VI.

*List of Agricultural Publications in India during 1919-20.*

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** | | |
| 1 | The *Agricultural Journal of India*, Vol. XIV, Parts IV and V, and Vol. XV, Parts I, II and III. Price Rs. 1-8 or 2*s*. per part; annual subscription Rs. 6 or 9*s*. 6*d*. | Edited by the Agricultural Adviser to the Government of India, Pusa. | Messrs. Thacker, Spink and Co., Calcutta. |
| 2 | Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist) for 1918-19. Price Rs. 1-4 or 2*s*. | Issued from the Agricultural Research Institute, Pusa. | Government Printing India, Calcutta. |
| 3 | Report on the Progress of Agriculture in India for 1918-19. Price Rs. 1-8 or 2*s*. 3*d*. | Agricultural Adviser to the Government of India, Pusa. | Ditto |
| 4 | Proceedings of the Board of Agriculture in India held at Pusa on the 1st December, 1919, and following days (with appendices). Price As. 12or 1*s*. 3*d*. | Ditto | Ditto |
| 5 | Notes on Practical Salt Land Reclamation. Pusa Agricultural Research Institute Bulletin No. 91. Price As. 6. | G. S. Henderson, N.D.A., N.D.D., Imperial Agriculturist, Pusa. | Ditto |
| 6 | The Orange: A Trial of Stocks at Peshawar. Pusa Agricultural Research Institute Bulletin No. 93. Price As. 6. | W. Robertson Brown, Agricultural Officer, North-West Frontier Province. | Government Printing India, Calcutta. |
| 7 | A Preliminary Note on the Behaviour in North India of the first batch of Sugarcane Seedlings distributed from the Sugarcane Station, Coimbatore. Pusa Agricultural Research Institute Bulletin No. 94. Price As. 8 | T. S. Venkatraman, B.A., Ag. Government Sugarcane Expert, Madras. | Ditto |
| 8 | The Effect of Manuring with Superphosphate and Sannai on the Yield of Crops on Indigo Planters' Estates in Bihar—especially of Rabi Crops in the season 1918-19. Pusa Agricutlural Research Institute Indigo Publication No. 6. Price As. 6. | W. A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist, Pusa. | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 9 | Guide to Agricultural Section, Pusa. (*Not for sale.*) | Compiled by Agricultural Section, Pusa. | Government Printing, India, Calcutta. |
| 10 | Motor Tractors at Lincoln Trials (*free*). | Issued from the Agricultural Research Institute, Pusa. | Ditto |
| 11 | Annual Report of the Board of Scientific Advice for India for the year 1918-19. Price R. 1 or 1*s.* 6*d.* | Issued by the Board of Scientific Advice for India. | Ditto |
| 12 | Agricultural Statistics of India, 1917-18. Vol. I. Price Rs. 2. | Issued by the Department of Statistics, India. | Ditto |
| 13 | Agricultural Statistics of British India, 1918-19. Price As. 4. | Ditto | Ditto |
| 14 | Estimates of Area and Yield of Principal Crops in India, 1918-19. Price As. 8. | Ditto | Ditto |
| 15 | Report on the Production of Tea in India in the Calendar Year 1918. Price As. 8. | Ditto | Ditto |
| 16 | Report on the Production of Tea in India in the Calendar Year 1919. Price As. 8. | Ditto | Ditto |
| 17 | Agricultural Statistics of Bengal for 1918-19. Price Rs. 1-5 or 2*s.* 8*d.* | Government of Bengal, Revenue Department. | Bengal Secretariat Book Depot, Calcutta. |
| 18 | Annual Report of the Department of Agriculture, Bengal, for the year 1918-19. Price Rs. 2 or 3*s.* | Issued by the Department of Agriculture, Bengal. | Ditto |
| 19 | Season and Crop Report of Bengal for 1919-20. Price Rs. 1-6. | Ditto | Ditto |
| 20 | Insects of Ganja. Bengal Department of Agriculture Bulletin No. 1 of 1919. Price As. 1. | Ditto | Ditto |
| 21 | Annual Report of the Department of Agriculture, Bihar and Orissa, for 1918-19. Price As. 6 or 6*d.* | Issued by the Department of Agriculture, Bihar and Orissa. | Bihar and Orissa Government Press, Patna. |
| 22 | Season and Crop Report of Bihar and Orissa for 1919-20. Price Rs. 1-2. | Ditto | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 23 | Agricultural Statistics of Bihar and Orissa for 1918-19. Price As. 14. | Issued by the Department of Agriculture, Bihar and Orissa. | Bihar and Orissa Government Press, Patna. |
| 24 | Report on the Administration of the Agricultural Department of the United Provinces of Agra and Oudh for the year ending 30th June, 1919. Price As. 8 or 1*s.* | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 25 | Season and Crop Report of the United Provinces of Agra and Oudh for 1918-19. Price As. 12 or 1*s.* 6*d.* | Ditto | Ditto |
| 26 | Report on the Agricultural Stations of the Western Circle, United Provinces of Agra and Oudh, for the year ending 30th June, 1919. Price As. 6 or 8*d.* | Ditto | Ditto |
| 27 | Report on the Agricultural Experiment Stations in the Central Circle, United Provinces, for the year ending 30th June, 1919. Price R. 1 or 1*s.* 6*d.* | Ditto | Ditto |
| 28 | Combined Annual Report of Partabgarh and Benares Agricultural Stations, United Provinces, for the year ending 30th June, 1919 Price As. 6 or 8*d.* | Ditto | Ditto |
| 29 | Annual Report of the Kumaun Government Gardens for 1918-19. Price As. 4. | Commissioner, Kumaun Division. | Ditto |
| 30 | Annual Report of the Chanbattia and Sitoli Orchards for 1918-19. Price As. 4. | Ditto | Ditto |
| 31 | Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1919, Part I. Price As. 7 or 7*d.* | Issued by the Department of Agriculture, Punjab. | Government Printing Punjab, Lahore |
| 32 | Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1919, Part II. (Annual Experiment Record.) Price Rs. 2-12 or 7*s.* 1*d.* | Ditto | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 33 | Season and Crop Report of the Punjab for the year 1918-19. Price R. 1 or 1*s.* 6*d.* | Issued by the Department of Agriculture, Punjab. | Government Printing Punjab, Lahore. |
| 34 | Tables of the Agricultural Statistics of the Punjab for the year 1918-19. | Ditto | Ditto |
| 35 | Prospectus of the Punjab Agricultural College, Lyallpur (*Not for sale.*) | Ditto | Ditto |
| 36 | Annual Report of the Department of Agriculture, Bombay Presidency, for 1918-19. Price As. 14 or 1*s.* 9*d.* | Issued by the Department of Agriculture, Bombay. | Government Central Press, Bombay. |
| 37 | Season and Crop Report of the Bombay Presidency for 1918-19. Price As. 8 or 1*s.* | Ditto | Ditto |
| 38 | Work on the Manjri Farm for 3 years 1915-18. Bombay Department of Agriculture Bulletin No. 90 of 1918. Price As. 7-3 p. or 9*d.* | J. B. Knight, Professor of Agriculture. | Ditto |
| 39 | The Cultivation of Berseem in Sind Experiments at Sukkar. Bombay Department of Agriculture Bulletin No. 91. Price A. 1 or 1*d.* | Lokeram L. Relwani, L. Ag. | Ditto |
| 40 | Classification and Description of the Jowars of the Bombay Karnatak. Bombay Department of Agriculture Bulletin No. 92 of 1919. Price As. 10 or 11*d.* | G. K. Kottur, B. Ag. Cotton Supervisor, Southern Division, Bombay Presidency. | Yeravda Prison Press, Poona. |
| 41 | Palm *gul* manufacture in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 93. Price Rs. 1-3-9. | V. G. Gokhale, L. Ag., Deputy Director of Agriculture, Konkan. | Ditto |
| 42 | Investigation into the manures of the Salt Lands of Sind. Bulletin No. 96. | Issued by the Department of Agriculture, Bombay. | Government Central Press, Bombay. |
| 43 | Prickly Pear as a Cattle Food. Bulletin No. 97. | Ditto | Ditto |
| 44 | Fruit Culture as practised near Shikarpur, Sind. Bulletin No. 98. | Ditto | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 45 | The Rice Cultivation in the Larkana District (Sind). Bulletin No. 99 (Revised). | Issued by the Department of Agriculture, Bombay. | Government Central Press, Bombay. |
| 46 | Fodder Crops of Western India. Bulletin No. 100. | Ditto | Ditto |
| 47 | Fruit Culture in Palitana and Jamnagar. Bulletin No. 101. | Ditto | Ditto |
| 48 | Investigations on Potato Cultivation in Western India. Bulletin No. 102. | Ditto | Ditto |
| 49 | The Book of the Mango. Bulletin No. 103. | Ditto | Ditto |
| 50 | The Ganeshkhind Botanical Garden (Kirkee). Its Genesis and Development. Bulletin No. 104. | Ditto | Ditto |
| 51 | Cultivation of Jowar on varkas lands as a kharif crop in the Konkan. Leaflet No. 6 of 1919. | Ditto | Yeravda Prison Press, Poona. |
| 52 | The Marathi Agricultural School, Loni Kalbhar, District Poona. Leaflet No. 7 of 1919. | Ditto | Ditto |
| 53 | Supply of denaturalised Salt for agricultural purposes. Leaflet No. 8 of 1919. | Ditto | Ditto |
| 54 | Cultivation of Shabu Jowar on the rabi lands of the North Konkan. Leaflet No. 1 of 1920. | Ditto | Ditto |
| 55 | The Kanarese Agricultural School, Devi Hosur, District Dharwar. Leaflet No. 3 of 1920. | Ditto | Ditto |
| 56 | The Cultivation of Onions in Konkan. Leaflet No. 4 of 1920. | Ditto | Ditto |
| 57 | Calendar of the Agricultural College, Poona, for 1919-20. | Ditto | Government Central Press, Bombay. |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 58 | Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1918-19. Price As. 3 or 3*d.* | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 59 | Year Book of the Madras Agricultural Department for 1919. | Ditto | Ditto |
| 60 | Agricultural Calendar, 1919-20. Price A. 1. | Ditto | Ditto |
| 61 | Calender of the Agricultural College and Research Institute, Coimbatore. Price As. 12 or 1*s.* | Ditto | Ditto |
| 62 | Season and Crop Report of the Madras Presidency for 1918-19. Price As. 12 or 1*s.* 6*d.* | Ditto | Ditto |
| 63 | A Soil Survey of the Kistna Delta. Madras Department of Agriculture Bulletin No. 75. | W. H. Harrison, D.SC., M. R. Ramasami Sivan, B.A., Dip. Agri., and B. Visvanath. | Ditto |
| 64 | Note on Tobacco Cultivation. Madras Department of Agriculture Bulletin No. 78. | T. H. Barry . . | Ditto |
| 65 | Note on Tobacco Cultivation in Godavari Lankas. | Compiled from the experiences of T. H. Barry, Esq., of Cocanada. | Ditto |
| 66 | Control of Important Paddy Pests. | M. R. Ry. D. Balakrishna Moorthy. | Ditto |
| 67 | Cambodia Cotton. Madras Department of Agriculture Leaflet No. 4 of 1920. | H. C. Sampson, B.SC., Deputy Director of Agriculture, V & VII Circles, Madras. | Ditto |
| 68 | Cultivation of Cambodia Cotton in Ceded Districts. Madras Department of Agriculture Leaflet No. 5 of 1920. | S. Ramasami Pillai, Assistant Director of Agriculture, II & III Circles, Madras. | Ditto |
| 69 | Note on Sugarcane Cultivation for the use of the ryots in North Arcot, South Arcot and Chittoor Districts. Madras Department of Agriculture Leaflet No. 6 of 1920. | J. Chelvaranga Raju Garu, Deputy Director of Agriculture, IV Circle, Madras. | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 70 | Note on Tapioca Cultivation. Madras Department of Agriculture Leaflet No. 7 of 1920. | M. Govinda Kidavu, Assistant Director of Agriculture, VII Circle, Madras. | Government Press, Madras. |
| 71 | How to increase production of Crops. Madras Department of Agriculture Leaflet No. 9 of 1920. | D. Balkrishna Murthi Garu, Acting Deputy Director of Agriculture, I Circle, Madras. | Ditto |
| 72 | Report on the working of the Department of Agriculture, Central Provinces and Berar, 1918-19. Price R. 1 or 1*s.* 6*d.* | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Central Provinces, Nagpur. |
| 73 | Season and Crop Report of the Central Provinces and Berar for 1918-19. Price As. 8 or 1*s.* | Ditto | Ditto |
| 74 | Report on Agricultural Stations, Southern Circle, Central Provinces, for 1918-19. Price As. 8. | Ditto | Ditto |
| 75 | Report on Agricultural Stations, Northern Circle, Central Provinces, for 1918-19. Price As. 8. | Ditto | Ditto |
| 76 | Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1918-19. Price As. 8. | Ditto | Ditto |
| 77 | Report on Demonstration Work in the Southern Circle, Central Provinces, for 1918-19. Price As. 8. | Ditto | Ditto |
| 78 | Report on Demonstration Work in the Northern Circle, Central Provinces, for 1918-19. Price As. 8. | Ditto | Ditto |
| 79 | Report on the Agricultural College, Botanical and Chemical Research and Maharajabagh Menagerie, for 1918-19. Price As. 8. | Ditto | Ditto |
| 80 | Farm Yard Manure. Central Provinces Department of Agriculture Bulletin No. III, Farm. Price As. 2. | R. G. Allan, M.A., Principal, Agricultural College, Nagpur. | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 81 | Some Observations on the Cotton Cultivation. Central Provinces Department of Agriculture Bulletin No. IV. Price As. 2. | R. G. Allan, M.A. Principal, Agricultural College, Nagpur. | Government Press, Central Provinces, Nagpur. |
| 82 | Imported Ploughs and their Satisfactory Working. Central Provinces Department of Agriculture Bulletin No. V. Price As. 2. | Ditto | Ditto |
| 83 | Oilcakes: Their Uses as Cattle Food and Manure. Central Provinces Department of Agriculture Bulletin No. VI. Price As. 2. | F. J. Plymen, Deputy Director of Agriculture, Western Circle. | Ditto |
| 84 | Weeds. Central Provinces Department of Agriculture Bulletin No. VII. Price As. 2 | R. G. Allan, M.A., Principal, Agricultural College, Nagpur. | Ditto |
| 85 | The *Agricultural and Co-operative Gazette* (Monthly) from July 1919 to June 1920. Price As. 2 per copy. | Issued by the Department of Agriculture, Central Provinces. | Shalom Press, Nagpur. |
| 86 | Report on the Operations of the Department of Agriculture, Burma, for 1918-19. Price As. 8 or 1*s.* | Issued by the Department of Agriculture, Burma. | Government Printing Burma, Rangoon. |
| 87 | Season and Crop Report of Burma for 1918-19. Price R. 1 or 1*s.* 6*d.* | Ditto | Ditto |
| 88 | Agricultural Calendar for 1920-21 (in Burmese). | Ditto | Ditto |
| 89 | Annual Reports of the Agricultural Stations, the Assistant Botanist of the Northern Circle, the Assistant Entomologist and the Agricultural Chemist to the Government of Burma for 1818-19. Price Rs. 3. | Ditto | Ditto |
| 90 | (*a*) Minutes of a Conference of Officers of the Irrigation Co-operative and Agricultural Departments held at Maymyo on the 16th April, 1920. | Ditto | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| | (*b*) Sub-committee's Report on Water Measuring Experiments. | Issued by the Department of Agriculture, Burma. | Government Printing Burma, Rangoon. |
| 91 | Minutes of an Agricultural Conference held at Maymyo on the 17th April, 1920. | Ditto | Ditto |
| 92 | Minutes of an Agricultural Conference held at Maymyo on the 19th April, 1920. | A. McKerral, Deputy Director of Agriculture, Southern Circle, Burma. | Ditto |
| 93 | Guinea Grass. Burma Department of Agriculture Leaflet No. 52. | F. Clerk, Assistant Superintendent, Htawgaw | Ditto |
| 94 | Cultivation of Potatoes. Burma Cultivator's Leaflet No. 53 (in Romanised Kachin). | E. Thompstone, B.SC., Deputy Director of Agriculture, Northern Circle, Burma. | Ditto |
| 95 | Seed Storage. Burma Cultivator's Leaflet No. 54. | Ditto | Ditto |
| 96 | Cultivation of "Pesingon" (*Cajanus indicus*). Burma Cultivator's Leaflet No. 55. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 97 | Annual Report of the Department of Agriculture, Assam, for 1918-19. Price As. 8 or 9*d*. | Ditto | Ditto |
| 98 | Season and Crop Report of Assam for the year 1919-20. Price As. 8. | Ditto | Ditto |
| 99 | Report of the Fruit Experiment Station, Shillong, for nine months ending 31st March, 1919. | Ditto | Ditto |
| 100 | Report of the Kamrup Sugarcane Experiment Station for nine months ending 31st March, 1919. | Ditto | Ditto |
| 101 | Report of the Jorhat Agricultural Experiment Station for nine months ending 31st March 1919. | | |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 102 | Report of the Karimganj Agricultural Experiment Station for nine months ending 31st March, 1919. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 103 | Report of the Upper Shillong Agricultural Experiment Station for nine months ending 31st March, 1919. | Ditto | Ditto |
| 104 | Tables of Agricultural Statistics of Assam for the year 1918-19. | Ditto | Ditto |
| 105 | Cultivation of *dals* or pulses in the Assam Valley. Assam Department of Agriculture Leaflet No. 1 of 1920. | Ditto | Ditto |
| 106 | Cultivation of *dals* or pulses in the Surma Valley. Assam Department of Agriculture Leaflet No. 2 of 1920. | Ditto | Ditto |
| 107 | Annual Report of the Agricultural Experiments and Demonstrations in Assam for 1918-19. | Ditto | Ditto |
| 108 | Report on the Season and Crops of the North-West Frontier Province for 1918-19. Price Rs. 1-4 or 1*s.* 8*d.* | Issued by the Department of Agriculture, North-West Frontier Province. | Government Press, Peshawar. |
| 109 | Summary of Remarks on the Kharif Crop of the North-West Frontier Province for 1919. Price As. 7 or 10*d.* | Revenue Commissioner, North-West Frontier Province. | Ditto |
| 110 | Annual Report of the Agricultural Department, Gwalior Government, for 1918-19. | Issued by the Department of Agriculture, Gwalior. | Alijah Darbar Press, Lashkar. |
| 111 | Report on the Operations of the Department of Agriculture and Fisheries, Travancore, for 1918-19. | Issued by the Department of Agriculture and Fisheries, Travancore. | Government Press, Trivandrum. |
| 112 | Report on the work of the Department of Agriculture in Mysore for 1918-19. | Issued by the Department of Agriculture in Mysore. | Government Press, Bangalore. |
| 113 | *Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy. | Issued by the Scientific Department of the Indian Tea Association. | Catholic Orphan Press, Calcutta |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*concld.* | | |
| 114 | The *Journal of the Madras Agricultural Students' Union* (Monthly). Annual Subscription Rs. 2. | Madras Agricultural Students' Union, Coimbatore. | Literary Sun Press, Coimbatore. |
| 115 | The *Journal of Dairying and Dairy Farming in India* (Quarterly). Subscription Rs. 5 per annum (including membership). | Published by the Indian Committee of the Dairy Education Association, Quetta. | Messrs. Thacker, Spink and Co., Calcutta. |
| 116 | *Poona Agricultural College Magazine* (Quarterly). Annual Subscription Rs. 2. | College Magazine Committee, Poona. | Arya Bhusan Press, Poona. |
| 117 | The *Planters' Chronicle* (Weekly) | United Planters' Association of South India, Coimbatore. | Daily Post Press, Bangalore. |
| 118 | The *Indian Journal of Economics* (Quarterly). Annual Subscription Rs. 12. | Department of Economics, University of Allahabad. | Pioneer Press, Allahabad. |
| 119 | *Bengal Economic Journal* (Quarterly). Annual Subscription Rs. 10. | Bengal Economic Association. | The Calcutta General Printing Co., Ltd. |
| 120 | *Mysore Economic Journal* (Monthly). Annual Subscription Rs. 4. | Mysore Economic Conference. | Vokkaligara Press, Bangalore. |
| 121 | *Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual Subscription Rs. 3. | Mysore Agricultural Experimental Union. | Bangalore Press, Bangalore. |
| | **AGRICULTURAL CHEMISTRY** | | |
| 122 | The Phosphate Requirements of some Lower Burma Paddy Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, No. 5. Price Rs. 1-12 or 3*s.* 3*d.* | F. J. Warth, M.Sc., B.Sc., Agricultural Chemist to the Government of Burma, and Maung Po Shin, Assistant to the Agricultural Chemist to the Government of Burma. | Messrs. Thacker, Spink & Co., Calcutta. |
| 123 | Absorption of Lime by Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, No. 6. Price Rs. 1-2 or 2*s.* | F. J. Warth, M.Sc., B.Sc., Agricultural Chemist to the Government of Burma, and Maung Po Saw, Assistant to the Agricultural Chemist to the Government of Burma. | Ditto |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **AGRICULTURAL CHEMISTRY** —*concld.* | | |
| 124 | Proceedings of the First Meeting of Agricultural Chemists and Bacteriologists held at Pusa on the 24th February, 1919, and the following days. Price R. 1 or 1*s.* 6*d.* | Issued from the Agricultural Research Institute, Pusa. | Government Printing, India, Calcutta. |
| | **BOTANY.** | | |
| 125 | Studies in Indian Sugarcanes No. 5. On testing the suitability of sugarcane varieties for different localities by a system of measurements. Periodicity in the growth of the sugarcane. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. X, No. 3. Price Rs. 1-12 or 3*s.* | C. A. Barber, C.I.E., SC.D., F.L.S., Government Sugarcane Expert, Madras. | Messrs. Thacker, Spink & Co., Calcutta. |
| 126 | Studies in the Pollination of Indian Crops, I. Memoirs of the Imperial Department of Agriculture in India, Botanical Series, Vol. X, No. 5. Price Rs. 1-4 or 2*s.* 6*d.* | A. Howard, C.I.E., M.A., Imperial Economic Botanist; Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist; and Abdur Rahman Khan, Second Assistant to Imperial Economic Botanist. | Ditto |
| 127 | The Cultivation of Oranges and allied Fruits in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 95. Price As. 2½. | H. P. Paranjpe, B.A., Assistant Economic Botanist, Poona. | Yeravda Prison Press, Poona. |
| | **MYCOLOGY.** | | |
| 128 | A Pythium Disease of Ginger, Tobacco and Papaya. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. X, No. 4. Price Rs. 1-8 or 2*s.* 6*d.* | L. S. Subramaniam, Assistant to the Imperial Mycologist, Pusa. | Messrs. Thacker, Spink & Co., Calcutta. |
| 129 | Proceedings of the Second Meeting of the Mycological Workers in India held at Pusa on the 24th March, 1919, and following days. Price As. 11 or 1*s.* | Issued from the Agricultural Research Institute, Pusa. | Government Printing, India, Calcutta. |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **MYCOLOGY**—*concld.* | | |
| 130 | Budrot of Palmyra and Coconut Palms in Godavari and Kistna Districts. Madras Department of Agriculture Leaflet No. 8 of 1920. | Bhogappaya Sastri. | Government Press, Madras. |
| | **ENTOMOLOGY.** | | |
| 131 | The Rice-Leaf Hoppers (*Nephotettix bipunctatus*, Fabr. and *Nephotettix apicalis*, Motsch). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 5. Price Rs. 1-8 or 3*s*. | C. S. Misra, B.A., First Assistant to the Imperial Entomologist, Pusa. | Messrs. Thacker, Spink & Co., Calcutta. |
| 132 | *Lantana* Insects in India. Being the Report of an Inquiry into the efficiency of indigenous Insect Pests as a check on the spread of *Lantana* in India. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 6. Price Rs. 2-4 or 4*s*. 6*d*. | Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., Entomological Assistant, Madras. | Ditto |
| 133 | (*a*) New Indian Midges (*Diptera*). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 1. | E. P. Felt, State Entomologist of New York, U. S. A. | Ditto |
| | (*b*) Description of a Rhinocyphine larva from Shillong. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 2. Price As. 12 or 1*s*. 6*d*. (for both numbers bound together). | Major F. C. Fraser, I.M.S. | Ditto |
| 134 | The Sugarcane Borer and its Control. Bombay Department of Agriculture Bulletin No. 94. Price As. 4-3. | Ramrao S. Kasargode, L. AG., Assistant Professor of Entomology, Agricultural College, Poona. | Yeravda Prison Press, Poona. |
| 135 | A Contribution to our Knowledge of South Indian Coccidæ. Pusa Agricultural Research Institute Bulletin No. 87. Price As. 14 or 1*s*. 3*d*. | T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Acting Government Entomologist, Madras. | Government Printing, India, Calcutta. |

*List of Agricultural Publications in India during 1919-20*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY**—*concld.* | | |
| 136 | Second Hundred Notes on Indian Insects. Pusa Agricultural Research Institute Bulletin No. 89. | Compiled by Entomological Section, Pusa. | Government Printing India, Calcutta. |
| 137 | Rice Hispa Madras Department of Agriculture Leaflet No. 1. | T. V. Ramakrishna Ayyar. | Government Press, Madras. |
| 138 | Hairy Caterpillar. Madras Department of Agriculture Leaflet No. 2. | T. V. Ramakrishna Ayyar. | Ditto |
| | **VETERINARY.** | | |
| 139 | Annual Report of the Imperial Bacteriological Laboratory, Muktesar, for the year ending 31st March, 1919. Price As. 4 or 5*d*. | Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Government Printing India, Calcutta. |
| 140 | A Malarial Parasite in the Blood of a Buffalo. Pusa Agricultural Research Institute Bulletin No. 90. Price As. 6 or 7*d* | A. L Sheather, B.SC., M.R.C.V.S., Director and First Bacteriologist; Imperial Bacteriological Laboratory, Muktesar. | Ditto |
| 141 | Proceedings of the First Meeting of Veterinary Officers in India held at Lahore on the 24th March, 1919, and following days (with appendices). Price As. 8 or 9*d*. | Issued from the Agricultural Research Institute, Pusa. | Ditto |
| 142 | *Syngamus laryngeus* in Cattle and Buffaloes in India. Pusa Agricultural Research Institute Bulletin No. 92. Price As. 6. | A. L. Sheather, B.SC., M.R.C.V.S., Director and First Bacteriologist, and A. W. Shilston, M.R.C.V.S., Second Imperial Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Ditto |
| 143 | Statistics compiled by the Government of India from the Reports of Provincial Veterinary Departments for the year 1918-19. | Issued by the Revenue and Agriculture Department of the Government of India. | G. M. Press, Simla. |
| 144 | Annual Report of the Bengal Veterinary College and of the Civil Veterinary Department, Bengal, for 1918-19. Price As. 10 or 10*d*. | Issued by the Civil Veterinary Department, Bengal. | Bengal Secretariat Book Depot, Calcutta. |

*List of Agricultural Publications in India during 1919-20*—concld.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*concld.* | | |
| 145 | Annual Report of the Civil Veterinary Department, Bihar and Orissa for 1919-20. Price As. 12. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Press, Bihar and Orissa, Patna. |
| 146 | Annual Report of the United Provinces Civil Veterinary Department for the year ending 31st March, 1919. Price As. 8 or 9*d.* | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 147 | Annual Report on the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1918-19. Price As. 10 or 10*d.* | Issued by the Department of Agriculture, Punjab. | Government Printing Punjab, Lahore. |
| 148 | Report of the Bombay Veterinary College and Civil Veterinary Department, Bombay Presidency including Sind, for 1918-19. Price As. 6 or 9*d.* | Issued by the Department of Agriculture, Bombay. | Government Central Press, Bombay. |
| 149 | Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1918-19. | Issued by the Civil Veterinary Department, Madras | Government Press, Madras. |
| 150 | Rinderpest. Madras Department of Agriculture Leaflet No. 4. | F. Ware, M.R.C.V.S., Superintendent, Civil Veterinary Department, Madras. | Government Press, Madras. |
| 151 | Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1918-19. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Central Provinces, Nagpur. |
| 152 | Report of the Civil Veterinary Department (including the Insein Veterinary School), Burma, for the year ending 31st March 1919. Price As. 12 or 1*s.* 1*d.* | Issued by the Civil Veterinary Department, Burma. | Government Printing, Burma, Rangoon. |
| 153 | Report of the Civil Veterinary Department, Assam, for 1918-19. Price As. 8 or 9*d.* | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |

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XXII

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# Review of Agricultural Operations in India 1920-21

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1922

# PREFACE

A rearrangement of the subject matter of this annual review was made last year in order to avoid repetition and permit of easy reference to particular subjects such as crops, etc., without having to wade through the rest of the publication. Last year's arrangement has been again followed in the present volume. Last year a friendly critic in the press suggested the addition, as an appendix to the report, of an estimate in money value of the improvements effected by the Agricultural Departments in India. It has not been found possible to do this with any pretence to accuracy. An appendix has, however, been added giving an estimate of the area under crops grown from seed originally issued by the Imperial and Provincial Departments of Agriculture. The figures, it will be noted, now run into millions of acres.

PUSA,
*January 24th, 1922.*

S. MILLIGAN,
*Agricultural Adviser to the Government of India.*

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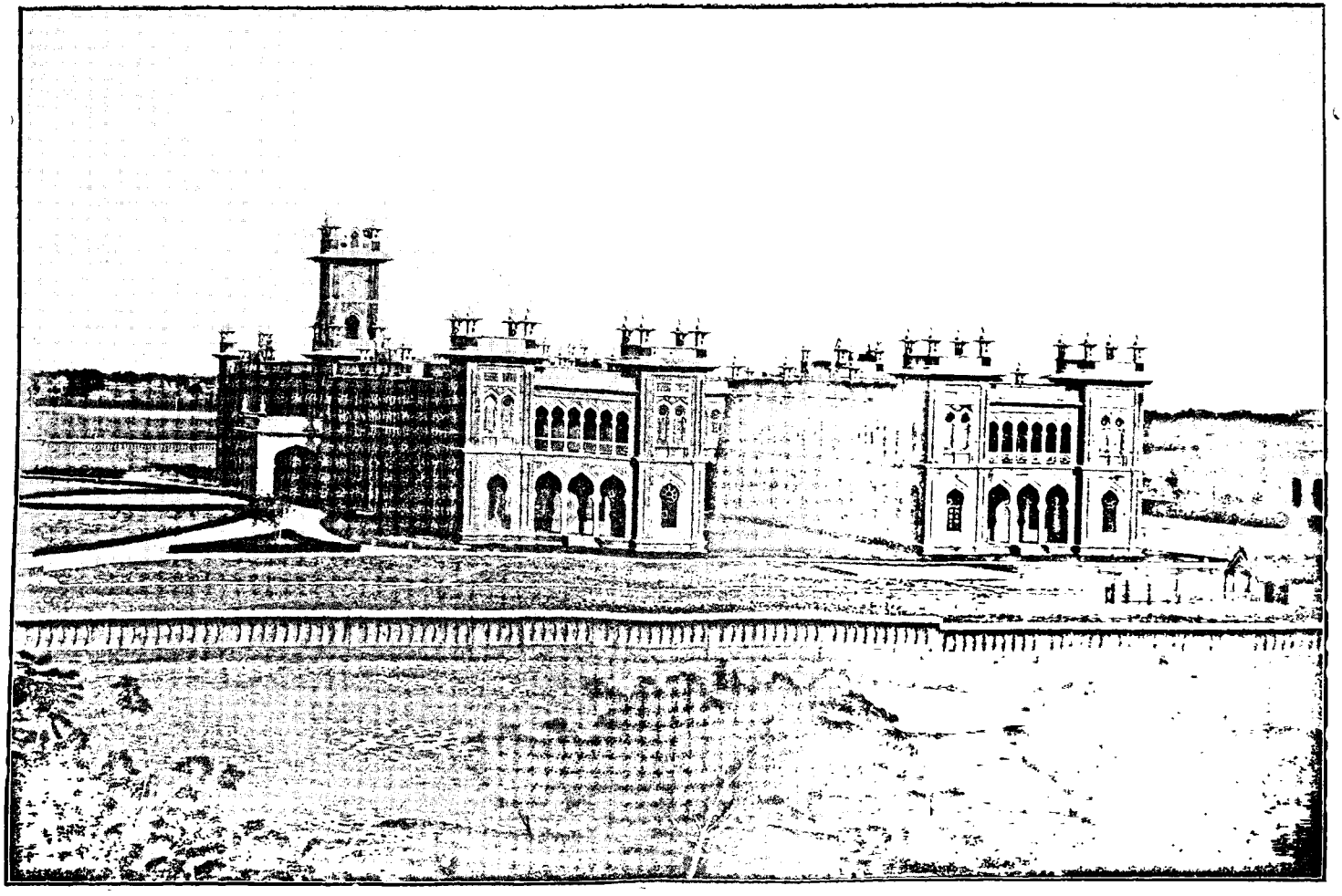


THE AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE, COIMBATORE.

# Review of Agricultural Operations in India 1920-21

## CHAPTER I.

### AGRICULTURAL CONDITIONS OF THE YEAR.

The monsoon of 1920 after making a good start, in the end proved disappointing. The average rainfall figure of the monsoon period over the plains of India, which this year was only 12 per cent. below normal, does not give a fair representation of the value of the rainfall to the country, as its distribution is probably of more importance than the total precipitation. The comparative failure of the rains in September not only seriously affected the standing *kharif* (monsoon) crops but was responsible for a large decrease in area in the succeeding *rabi* (winter crops).

Although the year was far from being a prosperous one for the agriculturist, no appreciable lack of employment for agricultural labourers is reported. Wages continued at a comparatively high figure.

The year was not altogether bad for live stock. On account of the dryness of the season, epidemics were less severe and the mortality amongst cattle was lower than in the preceding year. There was, however, considerable scarcity of fodder in several parts of the country.

## CHAPTER II.

## ECONOMIC WORK ON CROPS.

To the farmer possessing the necessary capital to supply irrigation water, plenty of manure and efficient tillage implements, the question of the suitability of crops to local conditions becomes a matter of little importance. To the Indian agriculturist possessing few of the advantages, crop varieties are all important, and the first and most obvious step in the improvement of his agriculture is to provide him with crop varieties suitable to existing conditions. For this reason the major operations of the Agricultural Department, an organization of very recent growth, have naturally been in the direction of the introduction of improved varieties of existing crops. The other side, *viz.*, the improvement of soil and other local conditions will be a matter of slower growth, as capital, or at least credit, will have to be forthcoming for its fulfilment. The chief advantage of varietal improvement lies in this, that although considerable skill, judgment and labour are required in the production and testing of improved strains, once established propagation is simple, and little, if any, extra cost is demanded of the grower.

Another advantage of varietal work on crops is that many diseases may be avoided through growing resistant varieties, while natural disadvantages such as short seasons, drought, etc., can be met in a similar manner. Improvement in agricultural methods will, however, in the end not only produce a better yield from existing varieties but will permit of better varieties being grown. Thus, although the most obvious advance is through varieties more suitable to local conditions, there are strong reasons for not neglecting the slower but more solid advance through cultural improvement.

***Rice.*** The outturn of the rice crop in India is always affected by shortage of rain in September, and while the area under it suffered a reduction from 79,426,000* acres in 1919-20

* Revised figure.

to 73,023,000 acres in the year under review, the yield of cleaned rice declined from 31,970,000* tons to 28,033,000 tons, the estimated yield per acre being 97 lb. and 99 lb. below the previous year and the last decennial average, respectively. The yield of the rice crop is a vital factor in the welfare of India, and, although no efforts can avail against bad seasons, the following brief account of the work of the Agricultural Department aimed at ultimately raising the average yield will give some idea of what is being and can be done in that direction.

Paddy being the main crop of **Bengal** occupies over 20,825,000 acres and naturally engages the chief attention of the provincial Economic Botanists.

The Indrasail transplanted variety has now fairly established itself in North and East Bengal and is spreading steadily, while the Kataktara *aus* variety, which has only recently been issued from the Dacca Agricultural Station, is already grown on large areas in the eastern districts and is fast spreading in the Presidency Division.

In addition, three new selections of *aman* paddy have been tested on a field scale and, as regards yield, they compared favourably with Indrasail, the best of the departmental selections now grown extensively by cultivators. One of these, Dudshar, is a week earlier than Indrasail and may, in consequence, prove very valuable for Western Bengal. Another selection, Tilakchari, has a very strong straw and will be useful for crossing. Both Dudenona and Banamanik have proved very promising and have yielded better than Nagra, a staple variety in Western Bengal. The question of early paddies for the high lands of Bankura and Birbhum has not yet been solved and has continued to receive attention.

A considerable amount of further progress towards the improvement of the crop has been achieved. Definite results have been obtained about the factors affecting the yield of paddy, while work on the inheritance of characters has indicated that many of them are inherited in groups and not independently. Work on transpiration of rice is in progress.

In **Madras,** work on similar lines, *viz.*, selection, multiplication and testing of pure strains of paddy and the cross-

* Revised figure.

fertilization of various strains in order to study the inheritance and linkage of the various characters of the paddy plant with the object of producing seed of improved types, has been equally successful. The selected strains already given out to growers, *viz.*, Nos. 24, 1303, 91 and 76, are becoming increasingly popular in the tracts suited to them. The Economic Botanist has in addition produced new strains which are better yielders and, as soon as these have been multiplied, they will be given out instead.

At Palur, two new short duration varieties were tried against three standard varieties, one of the new varieties, Vellai Manakathi, giving a good yield. At Coimbatore, the variety Poombalai yielded 3,234 lb. of grain per acre on ten acres.

Several series of experiments on paddy manuring are in progress.

In **Burma,** a collection of Shwebo paddies has been made and pure lines will be selected from them at Mandalay. At Hmawbi, work on paddies to suit different localities was continued, and some 60 varieties are under close observation. A recent selection, Letywezin B 107, which matures slightly later than Ngachima or Letywezin B 106, gives a higher outturn of fine quality rice more suitable for parboiling than either of the latter varieties. The late maturing Ngasein 10 is steadily growing in popularity. Emata A 34 continues to yield well and is being multiplied. Ngasein 8, however, has lately given reduced yields and will be replaced by a new strain. A short-lived type of Japanese paddy which is expected to be particularly suitable for the dry zone tract has been introduced in Meiktila and Myingyan.

Reports from all districts in which pure varieties of paddy are grown indicate that these command a premium of Rs. 5 to Rs. 15 above ordinary prices and are especially liked by small millers.

The results of the water measuring experiments so far recorded indicate that the best crops were produced on the plots which received a continuous flow of water throughout the season of growth.

An interesting investigation on the parboiling of rice has been carried out. The industry, though important, is a public nuisance owing to the objectionable fermentation which occurs. Good results were obtained by using acidulated water which inhibits bacterial activity.

Of the selected strains of rice now being propagated in the **Central Provinces,** G 13, L 7, Dacca 1, Bhondu 11 and Parewa 14 and 143 yielded over 2,000 lb. of grain per acre, while Bhata Gurmatia yielded about 1,900 lb. Tested against late and medium local paddies, these strains gave increases of 400 to 450 lb. per acre. Bhondu 11 is particularly promising as it ripens a fortnight to three weeks earlier and gives as high an outturn as the others. The classification of the wild rices of the province was completed during the year.

In **Assam,** a large number of pure single line selections were grown for comparison. As a result of the tests for the last three years, the department is now in a position to recommend an *aus* variety, M 36/30, to the cultivators. On an average it has given an increase of 450 lb. per acre over the local varieties. The superiority of Georgesail, Latisail and the Bengal selected Indrasail, over the local varieties, has now been definitely established, but on comparatively high land Latisail has proved more suitable than the other two varieties which do well in soils of medium level.

In **Bombay,** some of the selected strains from Kolamba rice are expected to give at least 33 per cent. increased outturn. The multiplication of the high yielding strains for distribution will now be taken up. Detailed work to determine the various factors which contribute to obtaining a maximum yield of rice is in progress. In Sind, two varieties of rice have been found to give large yields even under unsatisfactory conditions of watering, and, if this is confirmed, a very valuable result will have been obtained. The question of eradicating Gonag or wild rice in the *mallad* tract of the Southern Division is engaging the attention of the department.

In **Bihar and Orissa,** selection work on the farms was continued. Dahia, an early variety of paddy, which has proved a success in South Bhagalpur, also proved its superiority at

Ranchi over other medium *aman* paddies. Indrasail also was a success on the farm but a stronger strawed variety, able to withstand floods, will have to be evolved for areas outside the farm. On the Cuttack farm, 9 new varieties were compared with C. P. Loochai, Indrasail and Mahumachi which gave the highest yield last year. The result was that a coarse paddy called Pathermukta gave an yield of nearly one and a third times the yield of the above varieties.

Investigations into various **pests of paddy** were carried out in Madras. A vigorous campaign was also carried out in demonstrating methods of control of the rice hispa beetle in the South Kanara District. *Spodoptera mauritia* was checked successfully by digging trenches round the attacked area and collecting the caterpillars by winnowing fans, while in South Travancore the application of Paris green and slaked lime in the proportion of 1 to 40 was found to be very effective against this pest.

In Assam, the use of ropes to dislodge swarming caterpillars and the spraying of a thin film of kerosene oil on the water in the fields proved an effective remedy. A successful demonstration of the same method against rice-caseworm was also carried out in the paddy fields near Sorbhog. A mealy bug (*Repusia sacchari*) again made its appearance on the Karimganj farm but it was checked from spreading by promptly weeding out affected plants.

In Burma, investigation of *gwabo*, a disease causing yellowness in growing paddy and empty grains in a part or whole of the ear, was commenced, but only about five to eight infestations by borers were found.

The **ufra disease of paddy,** which has attracted considerable attention in recent years, was less prevalent probably on account of the flood caused by the cyclone of September 1919. A similar phenomenon has been noticed in previous years after heavy floods.

The work on diseases of paddy caused by *Piricularia* was continued at Pusa.

***Wheat*** stands next to rice in area as a single crop in India. The area under the crop fell from 29,949,000* acres in 1919-20

* Revised figures.

Pusa 4. Gorakhpur red.

THE IMPORTANCE OF STANDING-POWER IN INTENSIVE WHEAT CULTIVATION.

PLATE I.

to 25,722,000 acres in 1920-21 and the estimated total yield from 10,122,000* tons to 6,709,000 tons. The crop is grown chiefly in the Punjab, United Provinces, Bihar and Central Provinces. The failure of the monsoon in its later stages affected the area sown, while the outturn was still further reduced by the poor winter rainfall. The production during the year under review was 34 per cent. less than in 1919-20, the outturn per acre showing a decrease of 173 lb. and 111 lb., respectively, on that of the previous year and the average of the preceding ten years.

The Pusa varieties have now been extended to all the wheat-growing provinces, and the demand for botanically pure seed from the Institute for starting new centres of seed distribution and for restocking old ones continues to be great. As intensive cultivation increases and as the practice of growing wheat on the manurial residues of sugarcane spreads, standing power will become a more important factor in the choice of varieties. In Pusa 4, a wheat which is capable of producing a heavy crop without lodging, this contingency has, however, to some extent, been forestalled (Plate I).

The trials of some of the new wheats obtained by crossing Pusa 6 with a strong strawed heavy yielding parent were advanced a stage during the year. One of the objects of this work is to obtain an improved bearded wheat for parts of the country where the crop is damaged by wild animals and birds during the ripening period.

In the **United Provinces,** the area under improved varieties of wheat, predominantly Pusa 4 and Pusa 12, introduced by the department has now reached a figure at which accurate estimates cannot be made by departmental agency, but it is estimated, it cannot fall far short of 400,000 acres, giving the grower at a modest estimate an increased return of Rs. 15 per acre. The largest yield, hitherto recorded for Pusa varieties, was obtained last year, *viz.*, 3,034 lb. per acre. Supply of pure seed was maintained and 1,412 tons were distributed to cultivators during the year. Cawnpore 13 was tested again on different plots. The highest yield per acre was 2,924 lb. and

* Revised figure.

the average for 18 acres was 2,242 lb. per acre. Attempts are being made to encourage its cultivation in the Muttra District.

Among the varieties of wheat under trial in the **Punjab,** the two prominent competitors are the old established Punjab 11 and the more recent selection 8A. Both are distinctly better yielders than the local varieties. Punjab 11 having been longer on the market has hitherto had matters all its own way, especially in the canal colonies where the estimated sowing under the type amounted to about 634,000 during the year as against 377,500 acres in the preceding year. From a careful examination of the many comparative tests made between these wheats and others throughout the province, it, however, appears probable that Punjab 8A will in the end be even more popular in the province. It is as yet grown only by a few selected zemindars in the Lyallpur Circle, but in the Gurdaspur and Hansi Circles the areas under it are reported to be 1,200 and 4,000 acres, respectively. In the *barani* (non-irrigated) tracts Pusa 12 still continues to be the favourite. In Gurdaspur and Jullundur Districts alone, some 16,000 acres are reported to have been sown with this variety. Its quality of early ripening stood it in particularly good stead in the hot winds of last spring.

In the **Central Provinces,** Pusa 100, Pusa 12 and AO 89 again proved superior in yield to all other varieties tested. Irrigation experiments with this crop have shown that two waterings give optimum results. The increased yield over the unirrigated plots is, however, lower than what might be expected, *viz.*, 131 lb. per acre. Wheat grown after a monsoon crop has given satisfactory results over a number of years. The use of the Olpad thresher has been proved to be economical, reducing the cost of threshing from 4·6 to 1·2 as. per maund.

In **Bombay,** apart from the work on selection of pure strains suitable to the Deccan and Sind, extensive testings and distribution of the improved strains Pusa 4 and Pusa 12 have been undertaken.

In **Bihar and Orissa,** an important experiment was carried out on the Cuttack farm and also on a private estate in Cuttack District to test the possibilities of growing wheat in Orissa in

areas where the paddy crop had been destroyed by floods at too late a stage to permit of replanting. Pusa 4 wheat was quite successful and yielded 1,476 lb. per acre. In addition, large quantities of the seed of Pusa 12 were distributed in Bihar.

Pusa 4 and Pusa 12 gave satisfactory results in the Rajshahi Division in **Bengal** and will probably do well in other parts of the presidency. Selection work on the local crops, which are very mixed, has been started.

In **Burma,** there was a falling off in the demand for seed of improved strains of macaroni wheat (*Triticum durum*) from Padu and Mandalay. At Hopin, the yield was poor and it would appear that the climatic and other conditions in the Namyin valley are generally unfavourable to wheat.

At Yawnghwe, of the improved strains of Shan States wheat (*Triticum vulgare*), four gave yields averaging 30 per cent. more than the ordinary mixed variety, while the exotic wheats, Federation, Pusa 4, Pusa 6 and Pusa 12, have all again given very good results, the yields ranging from 1,230 to 1,370 lb. per acre on the dry upland and from 2,245 to 2,590 lb. on the moist lowland loams. The method of double cropping in which wheat follows potatoes in the same year has been demonstrated with success at Taunggyi and is now being followed by growers.

***Sugarcane.*** The area under this crop fell from 2,686,000* acres in 1919-20 to 2,553,000 acres in 1920-21 and the estimated yield from 3,036,000* tons to 2,465,000 tons. The outturn, affected by the poor monsoon, was 369 lb. and 183 lb. less per acre than in the previous year and the last decennial average.

Imports of foreign sugar amounted to 344,000 tons valued at Rs. 18,50 lakhs as against 482,000 tons of Rs. 22,99 lakhs value in the preceding year. A noticeable feature was the import of 1,766 tons of beet sugar, the first consignment of any importance since the war. Sugar is the only agricultural product in India in which the balance of trade is decidedly against her, and there are no two opinions on the necessity of putting the Indian industry on a sound and satisfactory footing. The publication during the year of the report of the Indian Sugar

* Revised figures.

Committee, which was appointed in 1919 to advise whether a definite and co-ordinated line of policy can be laid down for the promotion of further development of the Indian sugar industry, was most opportune. Some of the principal recommendations of the Committee are the establishment in India of—

(1) A sugar school for the training of Indians in the manufacture of white sugar, factory management, etc.
(2) A sugar research institute.
(3) A large demonstration factory.

The **Sugar Bureau** established at Pusa continued to give all possible assistance to prospective purchasers of sugar machinery by placing them in touch with manufacturers and arranging for early delivery of the machinery required. The Bureau has also undertaken the publication, for the benefit of sugar firms in India, statistical notes bearing on the production and consumption of sugar in different parts of the world and the fluctuations in the world's price of sugar. The Java method of rapid propagation of new varieties to avoid unnecessary delay before these can be given out to growers has been tried at Pusa with success. A similar experiment has been instituted at Dacca where conditions appear to be favourable.

One of the main features of the year's work as far as sugarcane is concerned has been the promising results attending the trials of the Coimbatore canes produced by Dr. C. A. Barber, late Imperial Sugarcane Expert, more especially the results of the crossing of thick canes with *Saccharum spontaneum*, a natural grass known in India as *kans* or *rahri*. Hybrids possessing the deep rooting character of the *Saccharum spontaneum* parent and sucrose content of the sugarcane have proved remarkably well suited to North Bihar and parts of the Punjab. At least one hybrid has appeared with the additional quality of early ripening which will supply a long-felt want to the cane-growers and to the sugar factories in North Bihar. Arrangements are being made for the rapid multiplication of this hybrid.

Over half of the total area under the crop in British India lies within the borders of the **United Provinces.** The Agricultural Department possesses for distribution a wide range of canes including imported varieties which have proved suitable for intensive cultivation. Amongst these may be mentioned M 16, J 247 and the varieties selected at the Sugarcane Research Station, Shahjahanpur; of the latter, a selection known as S 48 possesses the most attractive characters, and S 10 has been found to resist severe frosts remarkably well in other parts of the world also. Pure line selections of the best indigenous canes have been made and are being distributed. These include Saretha in the Meerut Division, Reora in the eastern districts and Rukra, an early ripening cane with a pure juice, in the Rohilkhand Division. Seedling canes from Coimbatore are undergoing careful trial: with a few exceptions they seem to possess remarkable vegetative vigour, although not quite up to the best indigenous and imported varieties in sucrose content.

Intensive cane cultivation has been most successful on land commanded by tube wells and pumping plants. The opening of the proposed Sarda Canal will offer an unrivalled field for the improvement of cane cultivation, as it will irrigate a tract the soil of which is specially suitable for canes. The introduction of power driven machinery for crushing cane on a relatively small scale for the manufacture of *gur* is becoming a pressing problem in the province.

In **Madras,** the most important work on sugarcane is being carried on on the Sugarcane Breeding Station at Coimbatore which supplies India with seedlings. Five new strains obtained from crosses were finally approved of during the year as suitable for trial in North India, bringing the total number of strains so being tried to 38. As mentioned above, very promising reports on some of these canes have been received. A very noteworthy feature of last season was the free arrowing of the Mungo group of canes, which it has not been possible to induce to flower hitherto. New methods of testing the fertility of sugarcane pollen and of keeping the pollen alive for periods up to 11 days have been worked out. This is most important as it enables cross-fertilization to be carried out between varieties which flower at different times or at different places.

On the presidency farms, cultural, varietal and manurial experiments were continued. At Samalkota, two Java varieties, Nos. 33 A and 247, have, for the last three years, given an average yield of nearly 11,000-lb. of *jaggery* per acre. At Coimbatore, Co 1, one of the Sugarcane Expert's seedlings, gave the best *jaggery* but only a moderate yield.

In the **Punjab,** Saretha again proved to be the best variety on the Lyallpur farm, giving at least 900 lb. of more *gur* per acre than the local variety Katha. On the Gurdaspur farm, Bihar and Coimbatore 205 stood at the top of the list.

In **Bihar and Orissa,** J 247 has sufficiently proved its superiority over other varieties to justify distribution for which it is now being grown. It is hoped that eventually about six varieties of nearly equal *gur* content will be evolved, ripening at successive times from December to March and thus enabling the ryot to spread his harvesting over a longer period. The system of growing cane in drained swamps proved eminently successful in withstanding drought. In Orissa, the extension of Mungo sugarcane continues but irrigation difficulties seem to place a limit to this.

In **Bengal,** the Yellow Tanna variety stands out pre-eminently as the cane best suited to the varying conditions of the presidency, and it has been decided to concentrate the department's efforts on introducing this variety over as large an area and as quickly as possible. The demand for this cane is great and to cope with it, seed farms are being established in the various cane growing tracts.

In **Assam,** a considerable amount of work was done on the testing and selection of varieties (local and exotic) under chemical control. The varieties found suitable for distribution so far are Striped Mauritius, B 147, B 376 and J 33A. Ten varieties ratooned gave an average crop of over 23 tons of stripped cane per acre, the highest yield being from J 33A. The heaviest outturn of *gur* per acre was however from Striped Mauritius. Of the new varieties of cane, the most promising were Coimbatore 9 and D 74, the former yielding 37 tons per acre of very high quality cane and the latter over 39 tons. The new Java varieties gave a fairly good account of themselves; they are hard

and erect and, with the exception of J 247, rather thin canes. Of the new Mauritius canes, M 55 and M 131 are the most promising. The highest yield of sucrose was given by Co 9 with an average of 10,024 lb. per acre. With regard to quality of juice, Co 9, B 6450, A2a and B 147 came out best.

In the **Central Provinces,** Khari again topped the list of canes under trial on several farms with an outturn of 4,160 lb. of *gur* per acre. Over a period of eight years this variety has given an average outturn of 2,488 lb. of *gur* per acre more than Katai and 2,364 lb. more than Kala, the two varieties it has replaced. The money value of these increases amounts, at present prices, to Rs. 276 and Rs. 262 per acre, respectively. Red Sport gave a yield of 9,950 lb. of *gur* per acre on the Jubbulpore farm and a net profit of Rs. 905. Some of the varieties obtained from the Sugarcane Expert at Coimbatore are very promising. The experiment started on the Tharsa farm in 1915 to ascertain the quantity of water required by cane indicate that the optimum quantity of water required per acre is approximately 100,000 cubic feet and that the optimum number of waterings is 29.

In **Bombay,** considerable success has been achieved in the investigations relating to the reduction in the present cost of manuring and the development of alternative types of cane, chiefly early ones, to the Pundya variety now almost exclusively cultivated. Three of the varieties, Red Sport, Manjri and White Transparent, are reported to have given very largely increased returns under difficult conditions of limited water supply.

Cultivation of sugarcane is rapidly extending in **Burma,** and the local Department of Agriculture is now unable to meet the demand for sets. Of the varieties supplied by the Sugarcane Expert, Coimbatore, five have proved very successful at Hmawbi, the best being Ashy Mauritius, B 147 and J 247. Gilman and B 147 are in great demand as canes suitable for chewing purposes.

There is a prospect of white sugar factories being opened in the Insein, Mandalay and Myitkyina Districts, and the cultivation of sugarcane is steadly growing in favour with small cultivators. The provision of a suitable cane crushing plant for the

small grower is a problem which is now being tackled by the department.

During the year a *jaggery* factory was opened at Hopin where cane was crushed and *jaggery* made for the growers at Rs. 7-8-0 per 360 lb.

In **Mysore,** the work of evolving high yielding varieties of cane by growth from seed is yielding good results. Special mention may be made of two seedlings which have given higher yields at Hebbal than Red Mauritius, the outturn of which in turn exceeds that of local Pattapatti by about 25 per cent.

Investigation on the eradication of red rot in sugarcane is in progress at Amalsad in the Bombay Presidency.

The borers of sugarcane continued to be the most serious of the pests of this crop. Work is being continued at Pusa on these and other pests of sugarcane.

***Cotton.*** During the year, the area under this crop fell to 21,016,000 acres from 23,353,000* acres in the preceding year and the total estimated yield to 3,556,000 bales from 5,796,000* bales of 400 lb. each. The yield per acre dropped to 68 lb. from 99 lb. and 79 lb. in 1919-20 and the average of the preceding ten years. The quantity of raw cotton exported during the year was 371,000 tons valued at Rs. 41,62 lakhs as against 428,300 tons valued at Rs. 58,65 lakhs in 1919-20. The value of cotton goods exported was Rs. 18,27 lakhs.

India stands second to America in the total production, but her cotton is shorter in staple, poorer in spinning value and smaller in yield per acre. The work of the Agricultural Department therefore aims mainly at increasing the yield per acre and improving the quality of the produce, and in these respects it has already achieved a considerable amount of success.

During the year, the Indian Central Cotton Committee, the formation of which was recommended by the Indian Cotton Committee, came into being. The main functions of the Committee are to act as a connecting link between the Agricultural Department and the cotton trade, and to act as an advisory body to Government on questions affecting cotton. In addition to these, it is hoped that the Committee will be provided with funds

* Revised figures.

to establish and conduct a technological laboratory in Bombay and to subsidize research on cotton problems.

**Bombay** Presidency, with an area of over five million acres under the crop, is the most important cotton growing province in India. The local Department of Agriculture, which has for a considerable number of years devoted much time to the improvement of cotton, has succeeded in isolating pure strains of the Surat and the Kumpta cottons, and in introducing them into cultivation on a large scale. By successful cross-fertilization between Kumpta and *G. neglectum*, a new hybrid has been evolved which promises to have as good a staple as Kumpta but a much higher ginning percentage and a much better colour. Efforts are being made to obtain by hybridization a cotton which will be equal to Navasari in staple but with a larger ginning percentage. Selection of strains of cotton suitable for the Broach area is being carried on, and it is hoped to start distribution operations next year on a large scale. Selection work on Dharwar-American cotton has resulted in the development of a pure strain, Gadak No. 1, which is now being spread over the district. For the conditions prevailing in Sind, Punjab-American 4 F has for some years been found suitable. Several excellent strains of Sind *deshi* cotton have been isolated.

In Surat the increased value of the cotton crops grown from seed selected on the Surat farm is estimated at Rs. 5 lakhs during the year under review. The possibility of further increasing the yield in this district by growing the crop on furrows appears likely from the results of the experimental work in progress.

Nearly half the acreage of cotton in the **Punjab** is now of the American type introduced by the Agricultural Department, the latest figures being *deshi* 635,250 acres and American 524,500 acres. Nearly all the American cotton now grown in the province is the 4 F type, but a new type, 285 F, is giving more satisfactory results in certain localities. Inspite, however, of the enormous area now occupied by American cotton in the province, it must be remembered that the introduction of the crop is a comparatively recent event and it is only to be expected that the present types will in time be replaced by something better.

The American crop is grown mainly in the western part of the province, while the important cotton-growing tract in the south-east still retains the old established *deshi* varieties. Work on these has shown the superiority of the white-flowered *neglectum* Bhatla as regards lint percentage, and a departmental selection recently issued is spreading in the Hansi Circle. Its lint percentage is over 37 compared to 33 or 34 per cent. of the local variety, and it is also a heavier yielder having given up to 1,476 lb. of *kapas* per acre in the hands of the cultivators.

In the **United Provinces,** the distribution of American cotton known as Ca 9 was continued but unfortunately the area fell from 8,100 acres to 3,380 acres on account of a shortage of water at the time of sowing. The market for American cotton is now established in Cawnpore and the prices offered are independent of those offered for *deshi.* Last year, cultivators of this class of cotton obtained about Rs. 4 per maund of 82 lb. for their *kapas* above the price ruling for *deshi kapas.*

Amongst *deshi* cottons, the pure line selection Jn 1, which is favoured by spinners, was distributed in Hardoi, Unao, Banda, Hamirpur and Jalaun. Its spread in areas for which it is suitable should go far to assist the mills to meet their needs locally. The Aligarh white-flowered cotton, on the other hand, is peculiarly suited to the dry tracts of the western districts and is very popular with growers in these areas.

Type K 22 was grown on departmental farms and distributed to cultivators in the neighbourhood of Raya farm.

The survey of the indigenous cottons of the province was continued and the collections made were grown and studied. Hybridization work with *Gossypium cernuum* and selection work on Perso-American cotton were continued, while some promising types with fairly long lints and high ginning values were tested for purity.

In **Madras,** with the appointment of the Cotton Specialist research work on this crop has received a great impetus. This officer has been primarily engaged in the improvement of Cambodia cotton. Work on *herbaceum* cotton indicates the existence of incompatibility between good length of lint and high weight of lint in this class of cotton, setting a limit to the production

of types combining high yield with good length of cotton. It does not, however, mean that improvements over existing crops are impossible.

The selected strains, N 14 of Northerns and H 25 of Westerns, which are now being given out to growers on a large scale, have secured large premiums over local cottons owing to their superior quality amounting to Rs. 55 and Rs. 49 per bale of 400 lb. With regard to strain N 14, Messrs. Binny and Co., who made a spinning test during the year, reported as follows :—

> The cotton has a very good white colour and is clean. The staple is longer than we usually get with this type and is regular. The blow room loss is 4 per cent. lower than the average for last season. Has good spinning qualities with a strength of 100 lb. for nineteen counts, which is very good. A very good cotton.

As regards Tinnevellies, yields at the rate of over 160 lb. of lint per acre were obtained from certain selections which promise to turn out better yielders than the standard types, Co 2 and Co 3.

In the **Central Provinces,** a start was made with single plant selections of indigenous cotton of medium staple as an alternative to the heavy yielding *roseum* which has been distributed by the Agricultural Department over a large area.

In **Burma,** selection and hybridization were continued at Tatkon. The cultivation of Tatkon 4, the white-flowered strain of Wagale, and of Cambodia was specially encouraged. The ginnery at Mahlaing has been very helpful in keeping seeds of Tatkon 4 free from mixture with other varieties, and it is proposed to extend the system to Allanmyo next year for the Cambodia cotton. Out of the single plant selections made at Mahlaing, plants of Shan cotton with a staple of 0·81 and a ginning percentage of 33 to 37 and of Wagi with a staple of 0·69 to 0·86 and a ginning percentage of 42 to 47 were obtained. Utopia did fairly well on a small area of upland soil at Padu and trials on a field scale will be carried out next year.

In **Bengal,** several varieties were again tested on the departmental farms but satisfactory yields were in no case obtained from long stapled varieties. It has been decided to initiate experiments with cold weather cotton this year, and a little seed

of what is believed to be the old Dacca cotton has been produced for the purpose.

In **Mysore,** the selections Nos. 45 and 69 have been favourably reported on by the local mills and seed is being distributed to cultivators. The work on Doddahatti (Dharwar-American) has been continued and strains have already been obtained which promise to be a distinct improvement on the mixtures now being grown.

The study of the parasites of **cotton bollworm** is in progress in several of the provinces. Important work on the stem weevil in Madras gives indication of the possibility of obtaining strains of cotton resistant to that pest.

***Jute.*** Amongst the lower grade fibres, jute is far and away the most important. India at present enjoys a monopoly of the world's production, conditional, however, on plentiful supplies of raw material at moderate prices. Owing mainly to lack of demand for the fibre and the comparatively high prices of food grains, the area under the crop fell from 2,509,000* acres in 1920 to 1,513,000 acres in 1921 and the estimated yield from 5,915,000* bales to 3,973,000 bales of 400 lb. each, the value of the export trade for the corresponding periods being 74,72 and 69,36 lakhs of rupees.

The crop is of great commercial importance in Bengal and is also grown on considerable areas in Bihar and Orissa and Assam.

The main economic work on the crop has naturally been undertaken in **Bengal** where varietal selection and crossing have been in progress for some years. As indicated in last year's report, the appearance of chlorosis of the leaf in the majority of the varieties of jute grown in Bengal offered a useful and obvious line of work, which proved almost immediately successful in the breeding of varieties free from the chlorotic tendency.

Two new races, R 85 and D 154, which are non-chlorotic strains of the well-known Kakya Bombai variety, have proved better yielders and are now being propagated on an extensive scale. Further investigations indicate a connection between the incidence of the disease and the development of the surface root system. Hybridization work with a view to combine the desir-

* Revised figures.

able characters such as yield, quality, rapidity of growth and freedom from chlorosis is in progress, one of the new hybrids showing great promise. Work on the length of ultimate fibres of jute has been renewed. Plants possessing the longest ultimate fibres have shown inferior yielding power. The composition of the jute plant at different stages of development has been studied in connection with the incidence of fungus diseases.

As stated in previous reports, a large amount of work has been done on the manuring of jute on the acid red soils of Eastern Bengal. The presence of sufficient lime and potash have proved to be limiting factors in the growth of the crop, but these are of no practical value except when used in combination.

It has now been definitely proved that late sowing is essential, when a seed crop is required, in order to obtain the best results and to avoid disease.

During the year the demand for seed of the new and improved varieties was greater than ever and could not be met. In the Dacca Division, for instance, 410,000 lb. of Kakya Bombai seed sufficient for 40,000 acres were indented for but only 65,600 lb. were available. The Bengal Agricultural Department is still dependent for its supply of jute seed of the new varieties on the planters in Assam and Bihar who grow the seed on contract. Trials are, however, being arranged with a view to ascertain whether a jute seed crop would not prove a profitable investment on lands too high for paddy in Western Bengal.

In **Assam,** the Bengal selected variety Kakya Bombai is easily superior to all local varieties, the average of the field trials held during the last six years showing an increase of 401 lb. per acre. The local department is making arrangements for an increased supply of seed for distribution.

The results of some trials with jute in the **United Provinces** indicate that on the typical low-lying lands in the area locally known as the *ganjar,* where no *kharif* crop of importance is possible owing to the uncertainty of the degree of flooding, good crops of jute can be grown without irrigation, if reasonable care is given to the crop in its early stages. These trials aroused

considerable local interest, and a number of applications for jute seed were received from taluqdars and zemindars in the Kheri and Sitapur Districts. It was decided, however, to advise applicants to wait until further experiments had been conducted in the Katesar and Rampur Mathurā estates.

It is reported that a small area of about 60 acres was sown with jute by the Indian cultivators in Einme Township in **Burma** and that the crop did fairly well. Labour difficulties, however, stand against an extended area under jute which is not likely to be grown except in small patches for local use.

***Flax.*** The experiments started on the Tarai and Bhabhar estates in the United Provinces were continued but were handicapped by lack of men trained in methods of flax-growing and the processes of retting and scutching.

***Other fibres.*** An improved variety of *pātwa* (*Hibiscus cannabinus*) known as Pusa Type 3 is being grown on at Pusa, where a small supply of pure seed is being maintained. Although this type does very well in many parts of India, the difficulty of obtaining pure seed in bulk militates against its spread. It is noteworthy that the type is proving equally successful in other countries, for instance, in South Africa, where the plants are reported to have "withstood drought and produced straight, unbranched stems from 10 to 14 feet in height and a yield of fibre of 35 maunds (2,870 lb.) to the acre on land freshly broken."

The breeding work on Roselle (*Hibiscus Sabdariffa*) has been resumed at Pusa.

***Indigo.*** The area under this crop rose from 235,300* acres in 1919-20 to 238,400 acres in 1920-21 and the yield of dye from 38,000* cwt. to 40,000 cwt., showing a slightly more favourable season. Exports, however, fell to 10,250 cwt., less than one-third of the previous year's. The present position appears to be uncertain, the German dye being again in the market in considerable quantities. In order that the natural product should be in a position to meet competition from synthetic indigo, it would seem necessary that not only should the yield per acre be

* Revised figures.

increased but that the present losses in the manufacturing process should be reduced to a minimum.

Past experience points to the conclusion that a supply of available phosphate is essential to the proper development of the plant, and that in some cases the supply of organic matter is of equal importance. There appears little doubt but that, with due attention to details, cultivation and manuring combined with the growing of varieties suited to the local conditions would lead to a very large increase in outturn. From the point of view of indican content the value of growing indigo amongst a cover crop such as wheat has been demonstrated. This practice was recommended some years ago by the Imperial Economic Botanist from a more general point of view.

The deterioration of indigo seed during storage and the conditions necessary to avoid this was investigated. The results indicate the importance of seed being well matured before gathering. Seeds with a specially resistant cuticle retain their germinative vigour to the greatest extent.

Investigations on the use of pure cultures of bacteria for the improvement of the process of indigo manufacture are in progress. The use of the new sterilizing agent made in the Pusa laboratory has brought the possibility of using pure bacterial cultures within the region of practical politics, and it is hoped that the efficiency of the manufacturing process will be greatly increased.

***Tobacco.*** With the recently imposed heavy duties on imported tobacco the prospects for the finer grades grown in India have improved considerably. The field is a large one as may be seen from the fact that last year cigarettes, etc., to the value of Rs. 296 lakhs were imported. The demand for the Pusa Selection Type 28, which combines yield and quality and is suitable both for cigarette making and general cultivation, has increased more than fourfold during the year when seed sufficient for about 50,000 acres was asked for and supplied. Recent trials of this type, made at Guntur in the Kistna Delta (Madras Presidency) by the Indian Leaf Tobacco Development Company, resulted in the production of tobacco which, according to a report of the Company, will be useful in the manufacture of cigarettes.

On account of its outstanding qualities, this variety is now being tried by the same firm in British East Africa, Kenya and Zanzibar.

The extension of cultivation of the acclimatized Sumatra tobacco grown on the Rungpur farm in Bengal will depend largely on the success of the efforts to improve the curing of the leaf. Marketing presents temporary difficulties which will doubtless be overcome once the area is sufficiently extended. Encouraging results have been obtained with some of the Burirhat farm varieties in Mymensingh and other parts of Bengal.

The experiments with the Rungpur varieties of tobacco, in progress in Assam, appear also to be promising. In the Lusai Hills imported varieties of tobacco were successfully grown at Lungleh and at the Dhubinalla garden.

In Burma, Pusa Type 28 is being grown on a small scale in Prome and is reported to fetch almost double the price of the ordinary local product, but there the problem relating to improvement of tobacco is primarily one of curing and no real improvement is likely to be attained until a tobacco-curing expert is appointed to the province.

***Oil-seeds.*** The area under the principal varieties of oil-seeds—linseed, rape, mustard, sesamum, groundnut, etc.,—rose from 13,388,000* acres in 1919-20 to 14,838,000 acres in 1920-21 but the yield fell from 2,843,000* to 2,416,000 tons. The total quantity of oil-seeds exported during the year was 624,000 tons valued at Rs. 16,84 lakhs as against 825,000 tons valued at Rs. 26,27 lakhs in the previous year, and that of oil-cakes 95,000 tons as against 143,000 tons in the preceding year. The fall in the exports, not only of oil-seeds and oil-cakes but also of vegetable oils, is attributed mainly to the relatively higher prices obtainable in local than in foreign markets. While foreign prices during 1919-20 were tempting and exports were in consequence heavy, local needs were imperative during the year under review and were able to out-bid a weak foreign demand. India's consumption of vegetable oils and oil-cakes constitutes a very large proportion of the total production, and the quantity nor-

* Revised figures.

mally absorbed by the foreign markets constitutes a useful surplus which can be drawn upon in bad years.

*Linseed.* Considerable progress was made at Pusa in the isolation and study of the unit species which make up the Indian linseed crop of commerce. The testing of some of these has commenced and is yielding promising results.

*Safflower.* A Bulletin dealing with the species of Indian safflower and the commercial possibilities of safflower oil has been recently published by the Botanical Section, Pusa. Mr. S. Stewart Remington, who carried out the latter part of the work at his laboratory at Aynsome, Grange-over-Sands, Lancashire, reports that the "oil should become a very valuable economic product if it can only be brought over and utilized on the Home markets. It should be an excellent oil, if properly manipulated, for the colour, paint, and varnish industries, also for soap and linoleum manufacture, as well as for edible and culinary purposes, in the latter cases if proper means are devised as regards refining and bleaching."

*Sesamum.* In Burma, 185 types of sesamum have been isolated by the Agricultural Department, while in the United Provinces, a collection of the varieties of sesamum was made and a preliminary classification carried out.

*Groundnut.* In most provinces the importance of this crop is increasing. In Bihar and Orissa, the variety found to be the best under the local conditions is the 3-kernelled Upright type, while in Burma, the Erect type of groundnut is regarded with great favour and is spreading rapidly. The Japanese Small variety gave a high yield, was found easy to harvest and had a high oil-content. The Spanish type, on the other hand, which was tried on *mogaung* land in Shwebo, suffered from drought; the ease of harvesting, however, makes it popular with the cultivator. The Pondicherry and Big Erect types have given exceptional results at Yawnghwe. In Thayetmyo, the Spanish and Japanese types are most in favour.

*Castor.* The Bihar and Orissa selections, Nos. 1 and 7, have given good results during the last two years, but the work on selection by oil-content seems to indicate that high oil-content is not generally transmitted.

A collection of castors from Bundelkhand was made by the United Provinces Department of Agriculture with a view to selecting types with high oil-yielding properties.

*Coconuts.* In Madras the study of coconut palm was continued on four stations. It has been proved that the local practice of planting coconuts in deep pits sunk well below ground-level is quite unnecessary. The advantages of intercultivation continue to be well marked. During the year, investigations into the correlations existing between the harvesting time, size of nut and oil-content, also regarding the sugar-producing qualities of the coconut, were initiated. The ash of the bearing tree was found to contain more potash and less lime and phosphoric acid than that of a barren tree.

In Burma, the question of coconut planting has aroused considerable interest. A small plantation with selected Burma and Madras nuts is being arranged for at Hmawbi, and a number of dwarf coconuts, which are reputed to bear in the fourth year, have been obtained from the Federated Malay States for experiment. It is unfortunate that coconut palms along the sea-board in Thaton are being ruined by the Rhinoceros beetle which finds ideal breeding places in manure heaps and decaying straw. Only combined and continuous effort, however, on the part of the people living in and near about the coconut gardens, can keep the pest under control and reduce its ravages.

In Travancore, the experiments to determine the effect of variations in temperature, rainfall and moisture contents of the soil on the dropping off of immature coconuts were continued during the year. Manurial experiments and variety trials are also in progress. The campaign against *Nephantis serinopa*, a serious pest of coconuts, was carried on vigorously, and the leaves of some 65,000 coconut palms were cut and burnt.

***Tea.*** The total area under tea was returned at 701,000 acres during the year under review as against 692,000* acres in the preceding year. The total estimated yield was, however, lower, being 345,340,000 lb. against 377,056,000* lb. in 1919-20, the outturn per acre being 52 lb. below that of the previous year and 35 lb. below the last decennial average.

* Revised figures.

Assam contributes between one-half and two-thirds of the total Indian output. Of the remainder, Northern India (excluding Assam) produces about twice as much as Southern India. The condition of the industry continued to be far from satisfactory owing to the prevailing low prices due to excess stocks in the United Kingdom and the withdrawal of the Russian demand. The slump in prices, however, was confined to the inferior grades, the finer qualities not being affected. Prospects of the current season appear to be more hopeful.

The Indian Tea Association continued to maintain a scientific department for the investigation of problems relating to the crop with the usual grant-in-aid from Government. The progress of work during the year has been satisfactory and some useful results have been achieved.

An investigation on the effect of different forms of manuring upon the composition of the tea plant was carried out upon seedlings grown in sand cultures. Different forms of manuring resulted in a different rate of absorption of the individual ingredients of the manure. The effect of potash manures was very marked in keeping the plants free from leaf fungus diseases. Experiments have confirmed previous results that inoculation of the bush with salts of potash increases its power of resistance to the mosquito blight.

In Southern India, the tea crop continued to receive special attention from the agricultural staff for the planting districts. At the Tea Experiment Station, demonstrations of the value of green manures, as a means of preventing wash and of increasing the organic matter of the soil, form an important part of the work in progress.

***Coffee.*** This crop is limited to South India. During the year under review, the new high yielding variety "Jackson's Hybrid" has proved its quality in the London market, a consignment from Malishwar Estate fetching top prices of Coorg coffee. This hybrid has thus shown that it not only yields heavily but produces a bean of a high quality, which can compete successfully in the market with standard grades of South Indian coffee. The next stage is for the planters to try the hybrid for themselves on an extended scale.

***Rubber.*** A great advance has been made recently in the general use of green dressings on the rubber estates in South India. Large areas are now under *Tephrosia candida,* a plant which grows well under the shade of old rubber and prevents soil erosion. The Rubber Mycologist has started work at Mundakayam, while seed selection work has been started at the experiment station at Mooply. A few trees appear to be resistant to *Phytophthora Meadii,* the fungus which causes an abnormal leaf-fall.

***Fruit.*** In our last Review we indicated the prospects of developing the fruit growing industry of India and the desirability of testing the system of co-operative marketing.

The work in Bombay followed chiefly on the lines sketched in the previous Review. An officer has now been appointed to work solely on horticulture, thus ensuring that the valuable work already done on fruit, more especially on mangoes, will be continued and developed.

In Madras, a real beginning has been made in the study of fruit culture by the establishment of a pomological station at Coonoor. The primary work of the station is grafting of standard imported varieties on the ordinary Nilgiri stocks and the production of seedlings and young plants for sale to fruit growers. In addition, varieties of fruit trees are grown in the experimental gardens at Burliar and Kallar. As the result of a successful demonstration on the spraying of grape-vines against mildew at Michael-patti in Madura District, the ryots are now willing to pay for the cost of spraying and some of them have gone the length of purchasing spraying outfits for themselves. A similar result at Sargodha in the Punjab was mentioned in last year's Review.

The prospects of improving date-palms in the Punjab appear to be good. About 6,000 suckers were imported during the year from Mesopotamia, of which over 3,800 were distributed to date growers. A gross income of Rs. 580 is reported for 17¼ cwt. of cured fruits of 240 Arabian date trees at Muzaffargarh.

The Assam Legislative Council having decided to discontinue the fruit-growing experiments at Shillong, steps are

being taken to close the station. Three new orchards have been started on Khasi cultivators' holdings, while the six orchards started last year are doing well.

Spraying operations were continued in the Punjab. Amongst other successful efforts may be mentioned those against *Citrus Psylla* and the mango hopper.

***Fodder Crops and Grasses.*** Crops grown purely for fodder form a very small proportion of the cattle food of the country, and mainly for this reason have not been subjected to the same systematic treatment as the staple crops. It should, however, not be forgotten that an improvement in the yield of the grain crops as a rule involves an increase in the straw as well as in the grain, and thus indirectly increases the amount of available fodder. Apart from this, the following special lines of work are worthy of mention.

In Bombay, a distinct advance has been made on the methods previously followed in the preparation of prickly pear as an emergency fodder. Of other crops, sunflower shows great promise as a fodder crop at the Gokak farm and *shevri* (*Sesbania ægyptiaca*) in the Deccan and Konkan. The results of the work on the improvement of grazing areas in the Bombay Presidency seem to indicate that the very poor value of these cattle ranges is due primarily to over-grazing and that consequently the resting of a portion of the land each year is desirable.

The experiments on utilizing for fodder the troublesome weed *baisurai* (*Pluchea lanceolata*), referred to in last year's Review, were repeated in the United Provinces. A ration of one-half green *baisurai* and one-half *juar* stalks was found to give better results than a full ration of *juar* stalks alone. It is estimated that, if the weed were properly utilized in the United Provinces, a saving of 215,000 tons of other fodder could be effected—a quantity more than the amount imported during the severest fodder famines.

In Assam, the comparative experiments with guinea-grass and rhodes-grass were continued at Jorhat. The yield from the former amounts to 37·6 tons of green fodder per acre and that of the latter 20·4 tons. An additional advantage in

favour of guinea-grass is that it establishes more readily than rhodes-grass and is altogether hardier.

At Coimbatore, 2·20 acres under guinea-grass, cultivated intensively, gave approximately the same outturn, *viz.*, 37 tons per acre, as in Assam.

In Burma, this grass is being grown with success at Hmawbi and at Mandalay. Saccoline, however, is more promising at the latter station, which was fit to cut for green fodder in about 90 days and yielded at the rate of nearly 11 tons per acre. Guinea-grass, irrigated, yielded three cuttings in the year, a total outturn of nearly 10 tons per acre. *Cumbu* millet (*Pennisetum typhoideum*) yielded 4½ tons of green fodder, lucerne 4 tons of green fodder in four cuttings, and sudan-grass nearly 4 tons of dry fodder per acre.

***Juar* (*Sorghum*).** The work in Bombay, Madras and the Central Provinces on this crop continued along previously laid down lines, the strains selected by the local departments being in good demand. The selections under trial in the Central Provinces gave exceptionally high outturns on the Hoshangabad farm; Lamkansi came out first with grain outturn of 1,959 lb. per acre and Saoner second with 1,800 lb. The use of a roller for threshing reduced the cost of this operation by one-half.

The effect of certain climatic conditions on the cyanogenesis of *juar* was studied in Bihar and Orissa and the results published in *The Agricultural Journal of India* (XVI, p. 381).

***Ragi* (*Eleusine coracana*).** This is the most important crop in Mysore State. Breeding work has been considerably extended. A number of single plant selections are being tested under varying conditions of soil and climate, and have shown themselves very much heavier yielders than any of the varieties the department has had heretofore. For instance, one strain yielded during the year 90 per cent. more than local Hullubile, one of the highest yielding varieties now being grown in the State. The high yielding strain Hebbel 22 has extended over 7,500 acres, the increased return to the ryots being put at not less than Rs. 1,12,000 at a conservative estimate.

***Potatoes.*** Scotch potatoes continued to beat the local varieties in yield in Simla Hills. Seed tubers are reported to have been in great demand. Hybridization has been effected by the Economic Botanist of the Punjab and the seedlings are already being grown.

In Assam, the acclimatizing, testing and distribution of potato seeds are carried on with the Upper Shillong farm as the centre of operation. Altogether 26 varieties were under trial. King of Potatoes, British Queen, Up-to-date and Imperator continue to give the heaviest yields, while on the other hand Magnum Bonum and Windsor Castle appear to be deteriorating. Of the three varieties obtained in 1918, Arran Chief has given good results. The demand for the selected tubers from the hills and the plains districts, as well as from outside the province, is increasing rapidly.

A new development towards the improvement of the crop through the growing of seedlings has been started at Kalimpong near Darjeeling.

Cultivation experiments in Burma have clearly demonstrated the futility of the local practice of growing potatoes on mounds on which cattle manure has been burnt.

In Bombay, considerable progress has been made in the study of potato diseases. All difficulties in dealing with the mite which causes the *tambera* disease have been overcome and the methods employed are now being demonstrated on a large scale. The investigations have been partly financed by the Sir Sassoon David Trust Fund and partly by the Union Agency of Bombay.

The disease *Phytophthora infestans* appeared again on the crop at Kokilmuk in Sibsagar (Assam), but was effectively checked by spraying with Burgundy mixture.

***Pulses and Beans.*** Considerable progress was made in the testing of some of the more promising of the Pusa types of gram. Over $1\frac{1}{2}$ tons of seed was distributed for this purpose in the provinces. At the Raya farm near Muttra, large scale trials of Pusa 17 and Pusa 18 gave 1,722 and 1,804 lb. of gram to the acre, respectively, in spite of the occurrence of premature hot winds when the plants were in flower.

In Bihar and Orissa, selected varieties of gram, Nos. 2 and 5, were distributed for trial against the Patna, Pusa and local varieties.

In Burma, the cultivation of gram on land flooded during the rains in Bassein has grown from a few acres in 1918-19 to over 1,000 acres in 1920-21. Experiments with gram obtained from Mandalay were not entirely successful. At Padu, Karachi gram has maintained its reputation for freedom from wilt and resistance to drought, and has produced crops in many cases where Burmese gram failed. Similar results were obtained in Lower Chindwin. Efforts are being made to get a compact area sown with this variety and thoroughly tested on a large scale.

Last year the area under Pebyugale (*Phaseolus lunatus*) dropped 200,000 acres, probably on account of the prussic acid scare. A further decrease of 31,000 acres has to be reported in the year under review. Experiments on the determination of prussic acid in fresh and old seeds are still in progress. Selection work on the crop has resulted in the isolation of five distinct strains giving beans of which bulk samples will be perfectly safe and which will, with reasonable care, keep below the danger mark for a long period. In the Southern Shan States, *pebyin*, a new selection of *Phaseolus vulgaris*, is being tried and arrangements are being made for a trial shipment of three tons for valuation in Europe.

At Jorhat in Assam, Burma bean produced 738 lb. of seed per acre. Of the varieties of *rahar* tried, Comilla white was the best.

*Dhall* (*Cajanus indicus*) is rapidly extending in Burma, and in the Lower Chindwin District alone over 5,000 acres are now under this crop.

## CHAPTER III.

## RESEARCH AND INVESTIGATION.

For details of the investigations in progress, their aims and objects and the results achieved, readers interested in any particular branch of agriculture or the sciences allied to it are referred to the Scientific Reports of the Pusa Agricultural Research Institute and to those of the provincial research officers, which are published separately.

For the information of the general public not likely to be interested in a technical review, we briefly indicate below only the main lines of work and developments not already recorded in the previous chapter under the different crops dealt with.

### I. Soils.

***Survey of soils.*** In *Bihar and Orissa*, the continuation of the soil survey into the Santal Parganas shows a greater deficiency of phosphates than in South Bhagalpur, and an increased poverty of nitrogen is found to occur as the hills are approached.

In the *Punjab*, a preliminary reconnaissance of the Sutlej Valley was undertaken.

In the *Central Provinces*, the study of the soils of orange gardens was continued. The results indicate that orange trees require a well drained soil and that the cause of oranges doing badly in certain gardens in Nagpur is the impervious subsoil common to these gardens. The results confirm those previously obtained in the Bombay Presidency.

In *Bombay*, work of a fundamental character on the method of maintaining a higher amount of water in the soil of dry areas has been undertaken.

In *Madras*, the final maps and tabular statements of the Godaveri soil survey are under preparation, and the analyses of soils in connection with the Periyar soil survey have been continued. Towards the close of the year the survey of the Malabar District was taken up.

***Bara soil reclamation.*** The reclamation of saline soils in the Punjab has been receiving attention for some years. In the reclamation experiments on the hard *bara* soils, sugarcane has been found not only to be the most successful crop grown but also satisfactory from the point of view of reclamation work.

***Soil moisture.*** Further work in this connection, specially with regard to the colloidal properties of the clay in soils by compressibility measurements and the effect of osmotic pressure of soil solutions on the moisture equilibrium, was continued in the Punjab. Work in connection with the percolation of water from a watercourse reported last year is finished and the results are ready for publication. The rate of the flow of irrigation water in the fields is under study.

***Soil biology.*** The losses of nitrogen from cattle dung and urine during storage under aerobic and anaerobic conditions were determined at *Pusa*. The losses from the dung were comparatively small, but the urine lost 85 per cent. of its nitrogen under aerobic, and only 15 per cent. under anaerobic conditions. Pot experiments with oats manured with cowdung and urine stored under different conditions showed that the yields correspond to the amount of nitrate formation in nitrification experiments in the laboratory. Similar results with oats were obtained from pots and plots manured with green manure, including roots, stems and leaves, taken separately, and the whole plant. A series of experiments on solubilization of rock phosphate by composting with cake or green manure has been started. The results indicate that, even in so highly calcareous a soil as that of Pusa, solubilization of phosphate by composting does take place.

The possibility of rendering the at present unavailable nitrogen of *mahua* (*B. latifolia*) cake and phosphate of rock phosphate of service to crops is the subject of further investigation. The investigations into nitrification and ammonification in various types of soils in the Madras Presidency have been continued.

The determination of the factors involved in the observed deleterious action of grass on fruit trees has been in progress at Pusa for some years. A mass of results on this question has been obtained during the year which will be published shortly.

Work on the influence on growth of the various factors involved in poor soil aeration has been continued.

A study of the fixation of potash and the liberation of bases by the acid soils of *Assam* showed that these are equal in most cases to the amount of potash fixed. In some clayey soils, however, the potash salt as a whole was absorbed.

Observations made in the *Punjab* show an average loss of soil nitrogen of 4·6 per cent. as compared with the results of 1919 when there was a gain of 3·5 per cent., showing an interesting seasonal variation. Protozoa examination of Lyallpur soils has been taken in hand. Larger ciliates, small ciliates, amobæ and flagellates are all found to be present. It has been found out that protozoa are present in Lyallpur soils even in the hottest and driest season of the year. Observations on the growth of algæ in liquid medium at Lyallpur show that growth begins to take place within 4 weeks in summer (April).

## II. Fertilizers.

The permanent manurial and rotational experiments started on the *Pusa* farm in 1908 were continued.

In *Madras*, the series of experiments on paddy manuring were continued. The general results may be summed up by saying that nitrogen and phosphorus increase the yield, whereas potash has, if anything, a depressing effect. Nitrogen, as with other cereals, especially tends to increase the yield of paddy straw. Phosphatic manures, more especially the comparatively insoluble mineral phosphates found in the Trichinopoly District, showed considerable residual effects.

Composting experiments with Trichinopoly phosphates showed that the maximum solution of the phosphates occurred after a week's composting, indicating very rapid fermentation.

With a sufficient supply of nitrogen, from a green manure, the phosphate is made use of by the paddy crop in comparatively large quantities. These results confirm experience at Pusa with *rabi* crops and in Bengal and Bihar with paddy.

The liming and manuring experiments at Jorhat in *Assam* laid down in 1909 were continued. All the plots treated with limestone carried fair crops of green *juar* followed by oats, the

heavier dr. ings of limestone producing the heavier crops. The value of basic manures and the beneficial effect of phosphoric acid, more particularly in its basic forms, were apparent, while the toxic effect of acid manures such as sulphate of ammonia, used in the absence of lime, was clearly demonstrated.

In *Bengal*, experiments on the red laterite soils of Dacca have shown that, over a series of six years, an average outlay of Rs. 18 per acre on lime, bonemeal and green manures on poor land has secured an increased revenue of Rs. 72 per acre per annum.

In the *Punjab*, green-manuring has been found successful in retaining moisture in light soils and in increasing the yield of the following crop.

### III. Windrowing of Sugarcane.

The work on the sugarcane enzymes and windrowing were continued at Pusa. So far as the season's results go, the windrowed cane was found to be decidedly superior to the cane which had been left standing uncut.

### IV. Diseases of Crops.

At Pusa the study of *Helminthosporium* on maize and *juar* has been concluded. It has been noted that *Helminthosporium* is found on maize only and not on *juar* in Bihar, and *vice versâ* in the Punjab. From the results of cross-inoculations it is concluded that there is no specialization of parasitism and that the fungus from one host can infect others. Thus cross-inoculations with *Helminthosporium* on maize and *juar* give reciprocal results and infections are also successful on sugarcane, wheat, barley, oats and to some extent on paddy but not on *bajra* (*Pennisetum typhoideum*). Rice and sugarcane *Helminthosporium* give positive results when cross-inoculated on maize, *juar*, wheat, oats, barley, rice and sugarcane. All the four strains on wheat give positive results on rice, maize, *juar*, oats and barley and some also on sugarcane. *H. teres* Sacc., which does a good deal of damage to barley in Pusa, was inoculated with success on wheat, maize, rice, *juar* and oats.

*Helminthosporium* on wheat, one of the causes of "foot rot," was obtained from America and is being compared in culture with the forms on wheat and barley occurring in Pusa. On sterilized wheat straw, it agrees very much with *H. teres* Sacc. on barley and on wheat in Pusa. *Helminthosporium* on barley and oats does a good deal of damage to seedlings and young plants. Last year it was present to a large extent on oats. It is intended to try control measures by treating the seeds before sowing.

## V. Insect Pests.

The study of borers in sugarcane and other gramineous plants is receiving special attention at *Pusa*. The general opinion that thin varieties of cane show a greater immunity from borer attacks than do thick ones and that the percentage of attack generally and gradually decreases with the growth of the canes has been confirmed. Dead-hearts and dry shoots occur practically wholly amongst young plants, those which are growing healthily being almost free.

A bad attack by Aphids on an experimental crop of wheat was checked in a few days by the liberation in the field of large numbers of Coccinellid beetles collected from other wheat areas on the farm. An attack of Red Spider on jute was controlled by spraying with crude oil emulsion and sulphur. The oviposition of *Monophlebus octocaudatus*, a Coccid which is usually a bad pest of fruit-trees and garden shrubs during the early part of the hot weather, is under study. Experiments on the survival of the eggs under different conditions are in progress. Steady progress was made in additions to, and arrangement and identification of, the collection of insect specimens.

Work on Tabanidæ (in connection with surra) and on Culicidæ was continued.

In addition to work on cotton pests, investigations into methods of protecting stored grain from weevil attack are in progress in the *Punjab*. Results obtained are not yet conclusive but the work is being carried on steadily.

Investigations of granary pests and of their parasites were also made in *Bombay*.

In *Bihar and Orissa*, the work on the braconid parasite of *Agrotis ypsilon* was continued. The absence of cold storage prevents the breeding of the parasite during the hot weather and the rains. All that has been possible to do is to collect cocoons and keep them dormant, ready for release on the appearance of *Agrotis ypsilon*. The problem has, however, possibly an agricultural solution in the better timing of sowings.

## VI. Useful Insects.

***Bee.*** No special work with bees has been possible except carrying on work at Pusa on a small scale with *Apis indica*. It was notable this year that *Apis dorsata*, of which a few migrant colonies often visit this locality for a short time in March, was present in small numbers during the rains of 1921. Various inquiries regarding apiculture have been dealt with and improved hives supplied.

***Lac.*** The emergence of the larvæ took place at Pusa on 22nd October, 1920, and 27th June, 1921, the latter being a late date. There is a great demand for broodlac, which cannot be met with the present resources at Pusa. A few small consignments of *Shorea talura* broodlac were received from Bangalore and placed on different kinds of lac-producing trees at Pusa, but the insects failed to establish themselves.

***Silkworms.*** Investigations into the more important diseases of silkworms were continued by the Protozoologist. A check on the results of the moth examination done by the Bengal Agricultural Department by means of a village census confirmed the value of this work of past years. Worms reared from village seed, that is to say, from eggs which have not been selected by microscopic examination of the moths, are found to be full of pebrine, while those reared in villages from seed supplied by the Government nurseries are singularly free from it, the nursery seed itself being reasonably good. Amongst other diseases, flacherie, so called, is found in a considerable number of cases, but this disease as found in India amongst multivoltine worms is evidently in no way comparable as regards its lethal qualities with flacherie in univoltines. It does not seem to be of very great importance in India.

Experiments conducted in the houses of village rearers in Bengal indicate that relatively little infection is acquired in this way. Thus good seed is, above all, important. The report of the Protozoologist dealing with these and other important questions relating to sericulture is now in the press. The Pusa hybridization and feeding experiments were continued.

In *Bengal*, cross-breeding experiments started in 1913 were in progress. Several multivoltine hybrids are stated to have been fixed, but the results of tests on a field scale are not yet conclusive. An attempt is being made to improve the indigenous races by methodical selections. A model silkworm rearing house has been constructed on the most approved lines and its value will be thoroughly tested.

The sericultural schools at Rajshahi and Berhampore and the primary school at the Pissbari Nursery (Malda), at which sons of professional rearers are given training in the principles of sericulture, continued to do useful work. Each pupil who passes the final examination of the Rajshahi and Berhampore schools gets a reward of Rs. 250 for the erection of a model rearing house.

The total amount of seed reared in the *Punjab* was 2,162 ounces as against 1,000 ounces in the preceding year. There has been an increase both in the number of districts and in the number of people employed in silkworm rearing in the province. Poor hatching and high temperature were, however, responsible for reducing the yield to 4 lb. per ounce of seed. The highest yield was 24 lb. per ounce as against 34 lb. in the previous year.

In *Madras*, the value of care in handling silkworms was successfully demonstrated and the immediate result was a 30 per cent. increase in the yield of green cocoons. A method of cleaning waste silk is being taught to reelers which is expected to result in a considerably higher price being obtained from waste. Efforts are being made to utilize chrysalids in the production of oil for soap-making.

Two expert reelers from Bengal have been engaged in *Burma* for instructing silkworm breeders in better methods of mulberry growing and reeling. As pebrine is mainly responsible

for the present state of the silk industry arrangements have been made for the distribution of disease-free seed from moths examined by the Pasteur method.

Attempts are being made in *Mysore* to put its sericultural industry on a firm scientific basis, and there appears to be every reason to be optimistic as to the results. Research and experimental work cover the entire range of sericulture from improvement of the breed of the silkworm to the improvement of raw silk. Reeling continues to be the weakest point in the State's silk industry and efforts are being made to remedy the defects. There is now a central sericultural school under the charge of a Japanese Expert, 3 taluk schools and 2 twisting schools. Short courses in silkworm rearing also are given in the farm and grainage at Mysore.

In *Travancore*, experiments on the different varieties of mulberry and silkworms were continued. The Italian variety of mulberry obtained from Pusa thrived best. Two private silk farms have been opened during the year and the prospects of the industry appear encouraging. The silk school continued to make good progress and 12 students passed out during the year.

Eri silkworm culture, started in the *Hyderabad* State about five years ago, is now fairly established. A few layings of mulberry silkworms supplied from Pusa were also successfully reared on the Alir farm and the breeding of these worms will be continued.

## CHAPTER IV.

### AGRICULTURAL ENGINEERING.

Engineering operations, so far as the Agricultural Department is concerned, are mainly connected with the improvement of the water supply of existing irrigation wells through connecting them with sub-artesian supplies by means of pipes or bores. Needless to say, work of this nature is of the greatest importance and the successful development of this branch has in many provinces added not a little to the prestige of the local Agricultural Departments. During the year under review, work has been handicapped by the high price of materials but good progress has, on the whole, been made.

In the **Punjab,** the number of bores sunk in wells amounted to 392 of which no fewer than 326 were successful in increasing the supply of water. The number of borings in districts where strainers had to be used amounted to 176 as against 149 in the previous year, all of which were successful. Five tube wells were in course of construction during the year. Of these, those at Jalalabad and Muzaffargarh have been completed and are working satisfactorily. A cheap form of bamboo pipe and strainer is being experimented with in order to reduce the cost of the present type which owing to high rates for metal pipes and strainers are out of the reach of all but wealthy zemindars.

In **Bombay,** Manfield's water finder has proved very useful in locating water supplies in the trap area. During the year, 194 shallow borings were made of which 131 were successful.

In the **United Provinces,** the progress made with the construction of tube wells during the year was disappointing, mainly owing to the fact that engineering material has risen enormously in price and is still difficult to obtain. The number of wells bored was 746, of which 513, or 68 per cent., are reported to be successful; 131 sites for new wells were bored, and 84, or 64 per cent., were returned as successful.

In **Madras,** the work relating to pumping and well boring was transferred to the Department of Industries during the year.

The main work of the Agricultural Engineer there will henceforth lie in the adapting of modern agricultural machinery and implements to the local conditions and the improvement of indigenous machines and implements.

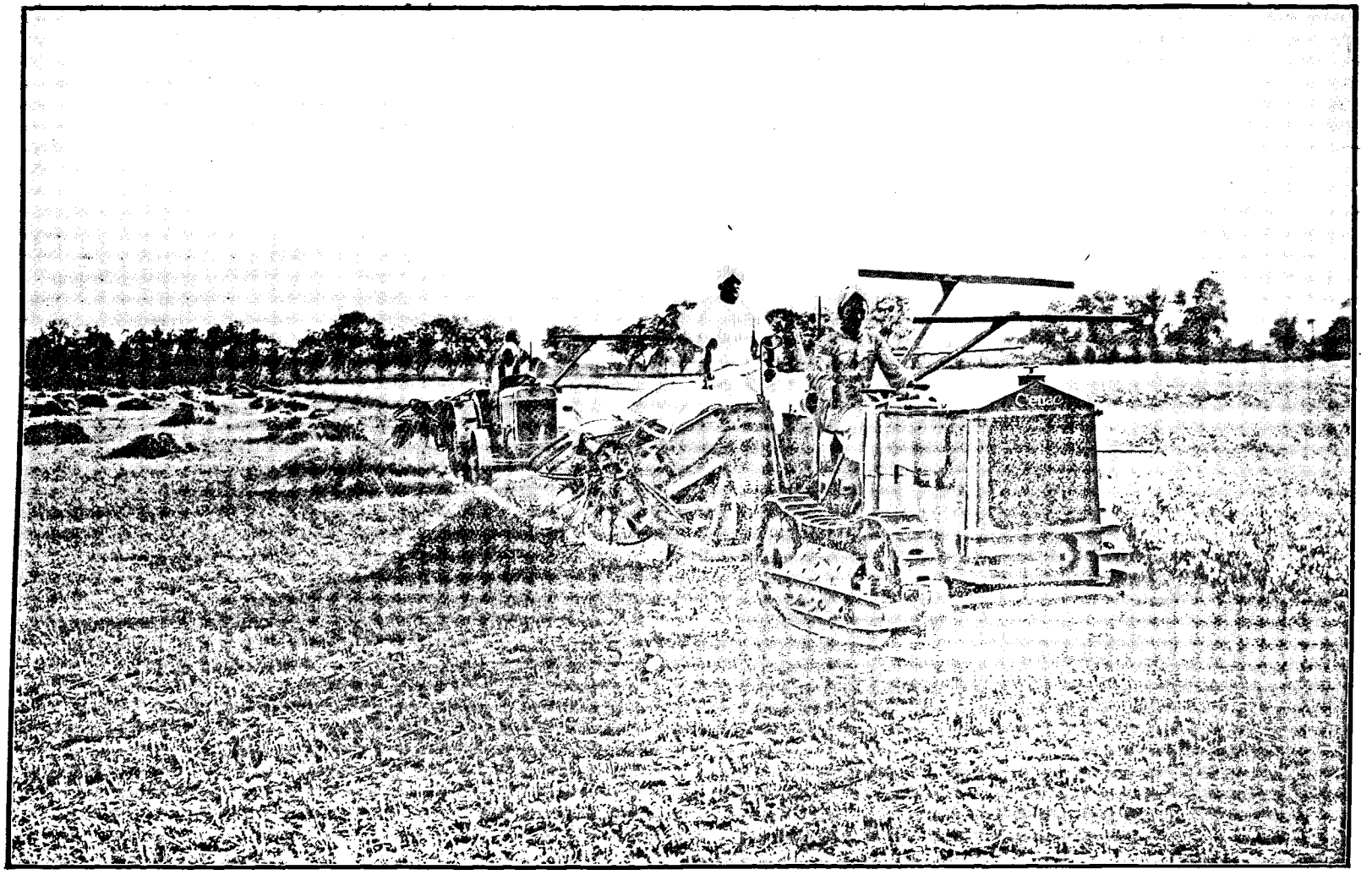
In **Burma,** the work of the Agricultural Engineer has up till now been practically devoted to buildings, etc., rather than to agricultural engineering proper. Several important problems such as tests of sugarcane crushers and furnaces, cost and efficiency of pumping installations, and improvements in indigenous farming implements are awaiting solution.

In **Mysore,** alterations have been made to the new model plough to meet the needs of the cultivators. An American drill has been altered to adapt it for sowing *ragi,* and an interculturing implement for sugarcane has been constructed. The Agricultural Engineer has also taken part in testing and trying modifications of the areca dryer and of *jaggery* boiling furnaces.

In **Baroda,** there was a considerable demand for well boring. Out of 105 bores sunk, 76 were successful. The power driven boring plant was naturally more popular. Useful work was also done in the installation of oil engines and pumps for which the State advanced Rs. 99,600 to 19 applicants.

As the result of advertisements by several firms and demonstrations held in several places, much interest has of late been evinced in **agricultural motor tractors.** It is reported that several large landowners have bought different types, and are trying them on their estates. The Agricultural Department is, however, not yet in a position to give a definite opinion as to the suitability of the different types of tractors to the various conditions of soil, etc., prevailing in the different provinces. Experiments are, however, in progress at Pusa and in most of the provinces, but some time must necessarily elapse before any conclusion of value can be arrived at.

In *Bombay,* some very carefully conducted investigations into the value and suitability of various types of motor tractors in the black soil areas of the presidency appear to have been conducted by the Agricultural Engineer. The results of the investigations will be shortly published.



THE "SELF-BINDERS" WORKING IN A LIGHTCROP OF OATS.

PLATE II.

From the experience so far gained with the use of certain types of tractor, the Director of Agriculture, *Madras*, is of opinion that—

the scope of tractor cultivation is limited in South India. The most valuable irrigated lands are unsuitable for tractor cultivation, as they are mostly cultivated in puddle, and are besides cut up into small plots. Almost the only chance for tractor ploughing is on the black cotton soils where fields are large. But here ploughing must be deep, *i.e.*, up to 10 inches, and the work is heavy as it has to be done when the soil is dry. Such work is beyond light tractors.

In the *Central Provinces*, there are some indications that, in villages where large areas have gone out of cultivation after being overrun with *kans* grass, ploughing by means of tractors may prove an economic method of bringing the land under cultivation again. A small beginning was, therefore, made by the department in ploughing land on the "hire" system.

The department gave a special course in the handling of motor tractors and tractor-machinery at the Agricultural College at Nagpur during the hot-weather vacation. The course was attended by several students.

The use of self-binders for harvesting grain crops with tractors is under trial at Pusa. Plate II shows the work of a pair of binders in the oats crop on the Pusa farm.

## CHAPTER V.

## DISTRICT WORK.

With a larger and better trained staff the Agricultural Departments are beginning to find that successful propaganda work is merely a matter of organization. The Indian cultivator has proved that his oft talked of conservatism is merely that of the sound practical farmer who requires good reasons for departing from well established practice. The chief obstacle in the way of improvement is not excessive conservatism but the lack of means.

In **Bombay,** for propaganda work agricultural associations, of which there are 68 in the presidency, and the large number of co-operative unions have been specially useful. A big success was scored in the extension of the area under improved cotton in Surat District where the premium on the crop grown in the few thousand acres under the supervision of the department was about 1½ lakhs of rupees. Demonstrations organized on cultivators' fields succeeded in establishing the use of sulphate of ammonia as a manure for sugarcane, especially in the Deccan canal tracts. Iron ploughs have, in parts of the presidency, become the ordinary cultivation implements.

In **Madras,** the distribution of seed of improved varieties of paddy and cotton called for a considerable expansion of the work. About 47,000 sets of cane were distributed from Samalkota farm, and the use of the Sindewahi furnace for making *jaggery* was successfully demonstrated. Over 600 tons of fish manure were distributed. The use of bone-meal combined with a green crop as a manure for paddy is rapidly extending. Work against smut was continued and 1,535 lb. of copper sulphate sold in 415 villages which was enough to treat the seed for sowing some 47,000 acres of dry crops. The agency of co-operative societies was generally useful in effecting improvements in ryots' lands, and sales of improved implements, manures, etc.

Public interest in agricultural matters shows a considerable increase in **Bengal.** An offer of land and a grant-in-aid has

been made by the Jalpaiguri Khas Mahal for a district farm. A demonstration farm has been opened in Bogra by the Karatia Wards Estate, and land for farms at Brahmanbaria and Jessore has been offered by the Bhowal Estate. District Boards are now supplementing the staff of the Agricultural Department by officers of their own and are also offering grants for the establishment of farms. Three prominent zemindars have opened seed and demonstration farms on their estates. Considerable progress has been made in the formation of village agricultural associations which are serving as useful links between the departmental officers and cultivators. The practice of re-excavating old tanks has become one of the chief items of work in Birbhum. A few irrigation co-operative societies have been started in Bankura for erecting and repairing *bunds*. The demand for improved varieties of paddy, jute, sugarcane, etc., is fast increasing and is already beyond the available supplies.

In **Bihar and Orissa,** successful demonstrations included improved methods of *gur* making, the use of gypsum and phosphates combined with green-manuring, etc. The District Board of Gaya made a grant of Rs. 5,000 during the year for demonstration work in the district. Co-operative societies were here also found to be useful bodies for propaganda purposes.

In the **United Provinces,** 70 seed depôts, supervised and controlled by the Agricultural Department, were worked during the year. The total amount of seed distributed was 2,000 tons, the largest on record. The number of private seed farms is rapidly increasing, a majority of which are making substantial profits. These farms fulfil very useful functions and are of assistance to the department in many ways, notably in demonstration work and the production of seed. Each farm serves as a seed depôt and as a centre from which improved methods spread to surrounding cultivators.

In the **Punjab,** the demonstration work has been supplemented by the opening of several demonstration farms by the Co-operative Department and private individuals. Thirty successful demonstration plots on the land of selected cultivators, the owner doing all the cultivation and receiving the produce, were conducted in the Gurdaspur Circle. The supply of seed

of improved varieties is a self-supporting organization. Seven hundred tons of wheat and 1,800 tons of cotton seed were purchased and sold during the year. The transactions yielded a net profit of about Rs. 3,042. A sum of Rs. 4,86,866 has been allotted this year for the distribution of seed of improved strains.

Twenty cotton sales were held, and 3,000 tons of cotton were disposed of as against 1,900 tons in the preceding year.

Inspite of increasing prices, the number of improved implements sold during the year rose to 944 from 432 in the preceding year. In addition to these, 693 country made implements were disposed of. A practical class is held at Lyallpur to train zemindars in the use of improved implements.

In the **Central Provinces,** 11 Government seed and demonstration farms were at work in addition to the large organization of private seed farms, seed unions and demonstration plots. Some of the seed unions and taluk agricultural associations are now engaged in introducing agricultural improvements in addition to growing improved seed. Four hundred and thirty tons of wheat, 10,000 tons of cotton-seed, 110 tons of paddy and 1,532,393 sets of sugarcane were distributed by the department, while improved implements worth Rs. 62,765 were sold to cultivators during the year. Single seedling transplantation, double cropping, sowing of *kharif* crops in lines, the working of fodder cutters, ploughs and cane mills, etc., were widely demonstrated. The McGlashan *gur* furnace was in great favour with the cultivators and large numbers of this new type of furnace were constructed in villages where sugarcane is grown.

In **Assam,** the demand for sets of the superior varieties of sugarcane was so great that the department was unable to meet it in full. Altogether about 150,000 sets were distributed. The 3-roller iron sugar mill is now firmly established. The number of mills sold through the seed depôt was 258, while four were issued for demonstration purposes. The use of water hyacinth ash as a manure for jute and potatoes was widely demonstrated.

The system of terracing recommended by the department is increasing in popularity in Naga Hills. The yield of paddy on terraced plots during the year was above normal.

In **Burma,** about 3,700 cwt. of pure strain paddy, 40 cwt. of cotton seed, 260 cwt. of groundnut and a very large number of sugarcane sets were distributed. Inspite of high prices for all implements, there was a good demand for improved ploughs and sugarcane crushers. Three hundred and fifty-five Cyprus ploughs, which are very useful for earthing up sugarcanes, and 19 sugarcane crushers were sold during the year.

The well organized work of the **Mysore** Agricultural Department in the introduction of improved implements, seeds and manures, was continued. A large number of co-operative societies are reported to have done useful work during the year. Another organization, the Mysore Agricultural and Experimental Union, continued to play an important role in the work of the agricultural improvement of the State.

In **Baroda,** the State Department of Agriculture has been successful in Navasari District in the popularization of the use of ammonium sulphate for sugarcane, of the short lift chain pump for paddy irrigation, and of useful cultivation implements. A special feature of the work of the department has been the distribution of a very large quantity of improved cotton seed in co-operation with the Bombay Department of Agriculture. The year's crop from the seed secured for the cultivator a premium of Rs. 5 to Rs. 10 and in some cases Rs. 15 per acre.

In Kuttanad in **Travancore,** ryots are following methods advocated by the Agricultural Department of cultivating *punja* lands annually instead of in every alternate year, and no less than 3,000 acres which would ordinarily have lain fallow during the year were brought under cultivation. More economical transplantation of rice has now become a common practice almost everywhere in South Travancore. The seed unions did useful work during the year.

The main feature of work in the **Hyderabad State** was the distribution of pure seed of the long stapled Gaorani cotton, of improved implements, oil engines, pumps and manures on the *takavi* system. Some 6,000 packets of copper sulphate for treating *juar* seed sufficient for about 24,000 acres were also distributed.

In **Kashmir,** demonstrations with chain harrows were held on cultivators' fields and seeds worth about Rs. 1,594 were sold. The popularization of Kashmir fruits has been more satisfactory during the year. Sugar beet was grown on a large scale, but the produce was utilized in feeding livestock and not for sugar making.

## CHAPTER VI.

### AGRICULTURAL EDUCATION.

For **higher agricultural education,** besides the Agricultural Research Institute at Pusa which provides facilities for post-graduate courses, there are agricultural colleges at Poona, Lyallpur, Cawnpore, Coimbatore, Nagpur and Sabour (Appendix III, p. 95), and it is proposed to shortly open similar institutions at Dacca and Mandalay.

The *Agricultural College at Poona,* which is affiliated to the Bombay University, continues to increase in popularity, the number of students on the roll being 205. A short course of one year in agriculture is also given to farmers' sons with a knowledge of English but not qualified to take the University course.

The *Agricultural College at Lyallpur* continued to provide two distinct courses, *viz.,* (1) the degree course which is subject to University rules and regulations, and (2) the certificate course. The B. Sc. examination results were not satisfactory, only six students passing out of eleven. The result of the certificate examination was more encouraging, 17 students passing out of 23.

In addition to these two courses, there is also a vernacular course dealing with practical agriculture to which 26 students were admitted during the year.

In the rural economy class, 22 students received instruction as against 18 last year. The number in the teachers' class remained unchanged. It is gratifying to note that the teachers trained in the college are doing useful work.

Fifty-four scholarships ranging from Rs. 7 to Rs. 50 per mensem, awarded by District Boards; Indian States and other provinces to their students, are being availed of. The value of the scholarship for post-graduate study extending over two years has been increased from Rs. 60 to Rs. 75 per mensem.

The *Agricultural College at Cawnpore* continued to provide two courses of instruction—the diploma course of four years

and the vernacular course of two years. In the four years' course, 15 students sat for the final examination all of whom obtained the diploma. In the two years' course, 17 students appeared in the final examination and 15 passed. Out of a large number of applicants for admission during the year, only 25 could be admitted to the diploma and 33 to the vernacular course on account of shortage in boarding house accommodation. Most of the students are connected by close ties with the land, and several of them have joined the college with a view to fit themselves for the management of their own estates. Another evidence of the growing demand for trained agriculturists is furnished by the fact that eight students have been sent to the college by owners of large estates with a view to their employment after having taken the course.

The question of affiliating the college to the Allahabad University was considered by a Committee who have recommended that the college, besides being admitted to the teaching side of the University, should be made over to the University to be managed and maintained by it. The recommendation, if carried into effect, would do away with one of the defects in the present organization by which scientific officers are made responsible for two distinct branches of work, *viz.*, teaching and research.

For the three years' diploma course in the *Agricultural College at Coimbatore* 28 applicants were offered admission but only 18 actually joined. As no fees are charged and the stipend of Rs. 25 per mensem more than covers all messing charges, it would appear that considerable encouragement is necessary to induce students from the educated classes to take to an agricultural career. Thirteen students appeared for the diploma examination and all passed.

For the two years' certificate course 39 were offered admission but only 26 joined. The falling off is apparently due to the fact that this course has lost much of its attraction now that it normally can only lead to the lower division of the Subordinate Agricultural Service. Forty-five students appeared for the certificate examination of whom 37 passed.

The preliminaries to the affiliation of the college to the University of Madras as a new department of science in the

existing Faculty of Arts and Science, and to the institution of a degree in agriculture to be known as B. Sc. Ag., have been worked out.

There was no change in the courses of instruction given in the *Agricultural College at Nagpur*. At the time of the annual examination in March there were only 47 students on the roll, but the number has since risen to 74. Nine students of the fourth year passed out successfully, 4 in the first division and the remainder in the second. In the third year there were only 4 students, all of whom passed in the second division.

The *Agricultural College at Sabour* in Bihar and Orissa continued to deal with a 2-year certificate course. Twenty-six students sat for the certificate examination of whom 14 passed. During the year there was only one scholar for post-graduate training but he shortly left the college for taking up an appointment elsewhere. Thirteen students attended the *bhadoi* and *rabi* short course classes.

Eleven post-graduate students were under training at *Pusa* during the year: three in general agriculture, one in agricultural chemistry, three in mycology, two in economic entomology and two in agricultural bacteriology.

In addition, an officer of the Indian Medical Department attended the Entomological Laboratory for two months for a short course with especial reference to the study of Diptera of sanitary importance.

Short courses in lac-culture and sericulture were taken by five and seven students, respectively, while instruction in sericulture not amounting to a regular course was given to six others.

**Agricultural high English and middle English schools.** Experiments in connection with agricultural instruction are being made in two schools in *Bengal, viz.*, at Durgapur H. E. School in Chittagong District and at Amarpur M. E. School in Burdwan District, both of which are mainly financed by local effort. Both the schools are reported to be doing well.

The agricultural school established at Bulandshahr in the *United Provinces* will soon be organized on lines similar to the

2-year course at the Cawnpore Agricultural College, intended primarily for boys who wish to take up agriculture at the end of their school life. Agriculture in different branches will be taught on the school farm, while the scientific teaching will be of a simple nature designed to illustrate and explain agricultural practice. The instruction will be mainly in the vernacular but English will be taught.

The syllabus for the agricultural middle schools at Chandkhuri and Powarkhera in the *Central Provinces* was revised during the year. The boys are taught the elements of the theory of agriculture, two hours a day being devoted to practical work on the school farm where boys grow their own crops. The period of training is for two years. At the Chandkhuri school there were 33 boys at the end of the year. The first batch of six students completed their 2-year course in March last, and the examiners were satisfied with the progress made. The number on the roll of the Powarkhera school never exceeded 19. The schools are still in the experimental stage, and there does not appear yet to be any appreciable demand for schools of this type.

The site for the proposed agricultural middle school at Taliparamba in *Madras* has been acquired, and it is hoped to open the school next year.

In *Mysore*, the two years' course in the Hebbal school has been replaced by one of 3 years. The number of pupils in the school at the end of the year was 24. Seven students were successful in the final examination out of a total of 9 in the class.

In *Travancore*, arrangements have been made to open an agricultural middle school for the training of practical farmers.

In *Bombay*, six **vernacular agricultural schools** at Loni, Jambul, Alibag, Devi Hosur, Godhra and Mirpurkhas were at work during the year. There were in all 158 students. In addition to these, 17 boys at the Bhil school near Dohad received a special short course of agricultural instruction. The schools are reported to be doing useful work, but the cost to Government for their maintenance is high.

The agricultural vernacular school at Dacca in *Bengal*, started in January 1920, made excellent progress during the

year. Unavoidable delay in building operations postponed the opening of the second school at Chinsura until February 1921. There were only 12 boys on the roll at the close of the year. These institutions, as at present constituted, are, however, too expensive to be adopted on a large scale. After the close of the year the whole subject of agricultural education in the province was discussed in a conference at Calcutta, and a definite line of policy with regard to the establishment of elementary and higher agricultural schools was drawn up.

It has been decided to establish a vernacular agricultural school at Pyinmana in *Burma*, and land is being acquired.

The vernacular agricultural school at Chikkanahalli in *Mysore* completed its fourth year of work. There were 14 students on the roll, all of whom passed the final examination.

In Bengal, the progress of nature study in primary schools and of agricultural classes in secondary schools is still far from encouraging. The unsatisfactory result is attributed to the want of properly trained teachers and of necessary funds for the maintenance of gardens.

**Training of subordinates and others.** In Assam, the training of apprentices for employment as demonstrators lasts two years. They get systematic instruction in elementary facts connected with agriculture and simple training in insect pests and their control. At the close of the year there were 8 apprentices each at the Karimganj and Jorhat farms, while the Upper Shillong farm had two.

It has been decided to open a class at Mandalay for training candidates for the Lower Subordinate Agricultural Service and to award stipends to the recruits.

Fifty elementary school teachers deputed by the various Taluk Boards in the Godaveri and Kistna Districts were trained in agriculture on the Samalkota farm (Madras Presidency), with a view to giving an agricultural turn to the rural education now imparted in the elementary schools, while 24 teachers were likewise trained on the Anakapalle farm.

The three half-time schools for juveniles and night schools for adult agricultural labourers on the farms at Coimbatore, Palur and Anakapalle in Madras continued to work during the

year. The schools at Coimbatore and Palur are doing fairly well but that at Anakapalle has failed to attract any of the labouring classes for the sake of education.

A class for ex-soldiers in elementary agriculture has been in progress at the Gurdaspur farm in the Punjab. It is a promising experiment, but in some cases the men selected for the class by the military authorities were not entirely suitable.

## CHAPTER VII.

## THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

The year under review has been marked by a much closer association between the Co-operative and the Agricultural Departments to the mutual benefit of both, although the growth of non-credit agricultural societies as compared with co-operative credit societies is slow (Appendix IV, p. 100). Many of the societies have directed their activities to new channels of usefulness and are engaged in experiments of great promise. Failures are by no means uncommon but the lessons will have their value if properly utilized.

The following facts and figures culled from provincial co-operative reports give some idea of the progress of the movement during the year.

**Bombay.** The growth in agricultural credit societies during the year has been gratifying. The total number is now 2,264 as compared to 1,993 in the preceding year. The working capital has increased from Rs. 1,08 lakhs to Rs. 1,33½ lakhs and the reserve fund from Rs. 7½ lakhs to Rs. 9½ lakhs. The owned capital of these societies now amounts to over Rs. 40 lakhs, of which Rs. 30·7 lakhs consists of members' deposits. Overdues have grown from Rs. 8½ lakhs to over Rs. 16 lakhs, but it is reported that this is due mainly to the adverse season.

The growth of non-credit agricultural societies was slow. The total number was 118 as against 102 in the preceding year. There has been a remarkable extension of the activities of the Co-operative Central Institute, Bombay, during the year. The training classes of the Institute attracted large numbers of college students and the general public. The instruction given is particularly valuable as it improves the work of the secretaries of co-operative societies to a considerable extent. In addition to a provincal co-operative conference which was held in Bombay in September 1920, eight district conferences were held during the year. The results of the night schools for adult

members of co-operative societies opened through the generosity of Sir Vithaldas Thackersey have been satisfactory. In all 29 such schools were working at the close of the year, but Sir Vithaldas has undertaken to provide funds for 40 such schools and 11 more will shortly be opened.

**Madras.** There was a net increase of 1,051 in the number of agricultural credit societies in the presidency during the year, raising the total to 5,207. The total working capital increased from Rs. 1,56,86,228 to Rs. 1,84,47,619 and the reserve fund from Rs. 8,19,592 to Rs. 9,65,238. The net profit earned by the societies was however Rs. 1,95,324 as against Rs. 2,09,327 in the previous year. The collection of overdue debts has again been very poor on account of a combination of circumstances, principally the bad season.

The number of agricultural non-credit societies rose from 62 to 67 during the year. Several of the societies did good work and earned fair profits, but a larger number worked at a loss. The Nidamangalam Manure Society dealt with seeds and other agricultural necessaries also to the extent of Rs. 5,676. The Garden Planters' Society in South Kanara did a fair amount of work and their sale proceeds amounted to Rs. 58,510. The dullness of the tobacco market, however, affected the operations of the Pallikeri Tobacco Growers' Society which sold tobacco to the value of Rs. 7,654 at a profit of Rs. 225.

**Bengal.** The number of agricultural credit societies rose from 4,920 to 5,786 and the membership from 147,923 to 162,241, while the working capital increased from Rs. 1,04,08,201 to Rs. 1,22,62,188.

The development of agricultural non-credit societies, though slow, has been steady, the number increasing from 58 to 63. Several of these did excellent work. The Khepupara store has erected, at a cost of Rs. 18,000, a godown to store 1,400 tons of paddy, which members have hitherto been forced to sell at a sacrifice for want of storage. The number of irrigation societies in Western Bengal has increased to seven, while there are several others in process of organization. The Irrigation Society at Khelar (Midnapur) again proved itself of great benefit to its members. The Salband Society in Bankura District

is now engaged in an irrigation scheme estimated to cost Rs. 40,000. Although affected for some considerable time by the non-co-operation movement, the financial position of the Naogaon Ganja Cultivators' Society continues to be a very strong one. The society made larger grants for education and sanitation and an allotment of Rs. 60,000 for a demonstration farm.

The Bengal Co-operative Organization Society continued to do useful work. It has been steadily developing as a bureau of information and advice.

**Punjab.** The number of agricultural societies increased from 6,831 to 8,014, membership from 1,82,516 to 2,14,411 and working capital from Rs. 1,78,46,207 to Rs. 2,21,11,467. As elsewhere, there has been a decrease in recovery of outstanding debts primarily due to the bad agricultural year.

One of the most interesting items is the progress of the Jhang Mortgage Bank. This institution is now in its second year of existence but it has already scored a considerable amount of success. It has hitherto advanced Rs. 73,000 and has thus helped in the redemption of 870 acres of land and a large number of date-palms and *sajji* trees.

The Seed and Demonstration Farm Society in Montgomery had a successful year. It is expected that a few more societies of this type will be started shortly. Through the agencies of co-operative societies there were sold to members, 488 Meston ploughs and 56 shares, 36 Raja ploughs, 330 Bar harrows, 17 drills, 42 fodder cutters, while over 250 tons of improved seed were distributed and over 50 demonstration plots were arranged for.

In our last Review we gave some account of an interesting scheme to promote the consolidation of holdings in the Punjab through the agency of special societies. So far the scheme has made healthy progress. There are 60 such societies now with 1,698 members, while 31 new societies have been formed but not yet registered. It is reported that repartition has been completed in 44 villages, with the result that 1,613 members have agreed to consolidate 6,350 acres. The number of fields has been reduced from 10,783 to 2,044, while the average size has been increased from three-quarters of an acre to four acres.

In 38 villages mutation has been sanctioned and in six others this is pending further enquiry.

The silt clearance societies have proved useful in arranging for the clearance of channels.

**United Provinces.** There were 3,488 agricultural credit societies at the close of the year 1919-20 to which 827 new societies were added during the year under review. This increase is the highest recorded in one year in the United Provinces since the inception of the movement. The working capital increased from Rs. 47,77,670 to Rs. 57,38,326 and the reserve fund from Rs. 9,01,333 to Rs. 9,76,375.

There were only ten non-credit agricultural societies during the year as against eight in the previous year. One central society formed in Hardoi with the object of supplying improved seed and implements to its members did excellent work. It distributed about three tons of *kharif* seed and sold eight tons of manure during the year, and had about 40 tons of Pusa wheat for the *rabi* sowings in stock at the close of it.

**Central Provinces.** There are now 4,535 agricultural credit societies in the Central Provinces. During the year, membership increased from 71,039 to 73,879 and working capital from Rs. 93,27,320 to Rs. 1,24,77,607. The average loans per member have risen from Rs. 131 to Rs. 154.

There are 34 registered agricultural societies for purposes other than credit, *viz.*, 6 for the purchase and sale of agricultural implements, 25 for production and distribution of pure seed, 2 for cattle-breeding and 1 for ginning cotton. Agricultural associations and seed unions have been of greatest assistance to the Agricultural Department in spreading a knowledge of improved agricultural practice and of the cultivation and distribution of very large quantities of improved seeds. The two cattle-breeding societies, however, failed to make a satisfactory progress.

**Burma.** The number of agricultural credit societies rose from 3,319 to 3,704, individual membership from 72,816 to 89,103, working capital from Rs. 1,24,63,673 to Rs. 1,44,53,403, and reserve fund from Rs. 17,52,006 to Rs. 21,91,797.

Of societies for production and sale, the Mahlaing Co-operative Ginning Factory is reported to have done good work. It ginned the cotton and through a rise in price sold the lint for the cultivators, obtaining nearly double the price prevailing at the time when the cotton was first brought to the ginnery. A co-operative paddy mill has been registered and another is being organized.

**Bihar and Orissa.** The number of agricultural societies working during the year was 3,247 as against 2,774 in the previous year. Membership and working capital of these societies rose from 79,732 and Rs. 38,08,758 to 95,112 and Rs. 48,32,591, respectively. The reserve fund also increased from Rs. 5,42,512 to Rs. 6,77,286.

Large quantities of improved seeds of different varieties of crops were distributed during the year. Progress in the sale of improved implements has been satisfactory and the construction of *bunds* for protection of crops is now engaging attention.

The agricultural sale societies, with the exception of two, worked on correct lines and made fair profits. There has been a considerable increase in the number of grain *golas* (stores) which rose from 10 to 31. The total membership has reached 10,753. The object of the *golas* is to afford relief to the members by giving them loans of paddy at reasonable rates and to create a reserve stock of grain for use during years of famine and scarcity.

**Assam.** The number of agricultural credit societies rose from 412 to 494, membership from 18,520 to 21,638, working capital from Rs. 5,15,469 to Rs. 6,15,279 and reserve fund from Rs. 1,48,517 to Rs. 1,68,567. There are no societies for agricultural production or for the sale of produce.

## Co-operative Milk Societies.

In *Bengal*, there were 40 milk societies during the year. They supply milk to Calcutta, where, on its arrival, the milk is handled by the Milk Societies' Union. Inspite of an unfortunate set-back during the year, the Union has again been working at a profit and is getting a regular supply of about 2,150 lb. a day.

In the *Punjab*, the Berhampur Milk Society (Gurdaspur) sold over 82,000 lb. of milk during the year and is said to have saved its members about Rs. 2,000.

In the *Central Provinces*, the net profit of the two societies of *gaolis* which work in conjunction with the Telinkheri dairy at Nagpur amounted to Rs. 8,630 during the year. The members now own a mixed herd of 217 milch animals, mostly cross-breds. There has been a general improvement in the average milking yields of the animals due to improvement in the breed and also in feeding.

In *Bombay*, the progress of the co-operative dairy societies was as a whole not quite satisfactory. There are, however, exceptions, especially those at Dhulia, Belgaum and Malvan. The total output of milk of these societies amounted to the value of Rs. 56,955 and their profits to Rs. 4,224.

The two co-operative milk supply societies in *Madras* did not do any work during the year.

## Cattle Insurance.

In the *Punjab*, cattle insurance which had been making steady progress for the last few years received a set-back during the year under review on account of the dry season. Seven societies ceased to exist, but on the other hand persistent propaganda resulted in the formation of 12 new societies. The number of animals insured declined from 587 to 499. Twelve died and compensation amounting to Rs. 647 was paid. The funds increased from Rs. 1,955 to Rs. 3,133. The Re-insurance Union made little progress.

In *Burma*, there has been a heavy decline in the number of societies which collected premia and reinsured from 272 to 115 (out of 381 registered societies) and a decrease from 4,590 to 3,028 in the number of cattle insured. The Re-insurance Society is sufficiently strong for its diminished business. It had to pay only Rs. 1,683 in indemnities during the year. There has been no demand for extension of the operations of cattle insurance.

## CHAPTER VIII.

## LIVE STOCK.

### I. Prevention and Treatment of Disease.

Details of the work done by the Civil Veterinary Departments during the year under review are given in tabular form on p. 104 (Appendix V). There were 574 veterinary hospitals and dispensaries at work during the year, and the cases treated and castrations performed at these institutions numbered 10,96,834. The small reduction from the previous year's figures is attributable to the discouragement of the unsatisfactory system of supplying medicine without first seeing the patient and diagnosing the disease. In addition, 6,76,131 cases were treated by the touring veterinary inspectors and assistants, making a total of 17,72,965. Thus during the last six years the number of cases has increased by 35 per cent., a testimony to the increasing confidence on the part of the Indian peasant in the work of the Civil Veterinary Department. As a further testimony to the popularity of the medical treatment of live stock, it may be pointed out that out of eight new dispensaries opened during the year in the Bombay Presidency, five were established through the help of popular contributions.

Taking India as a whole, live stock suffered less from contagious diseases than last year probably on account of the dryness of season in the greater part of the country. The total number of deaths reported from contagious diseases amounted to 2,88,375 as against 3,37,396 in the preceding year; 2,52,200 of these were due to rinderpest alone. The number of inoculations, on the other hand, rose from 7,09,795 to 8,56,853. Some of the difficulties met with in dealing with outbreaks are well summarized by the Veterinary Adviser to the Government of Burma :—

It is bad enough to fight against the natural sources of infection, which are numerous, but difficulties are infinitely increased when one has to fight against ignorance and the old established customs and prejudices of the people themselves. Cattle owners, when disease is prevailing in the village, often remove their cattle to another locality with

the idea of saving them, and it will take a long time before they can be made to realize that such movements of cattle are a means of spreading the disease. Unless or until the cattle owners themselves realize the importance of early information and segregation and helping the district officials and the veterinary staff in the suppression of these periodical outbreaks, disease must remain a source of loss to them and a danger to agricultural interests in general.

Inspite of the strengthening of the staff of the Civil Veterinary Departments it is still far from possible for the departments to meet the calls made on them for help, especially during periods of epidemic. Although on account of the inefficiency of the reporting agency, all outbreaks are not reported, still quite a number of known outbreaks remain neglected for want of men to attend to them. For example, in the Central Provinces 13 per cent. and in Bihar and Orissa 19 per cent. of known outbreaks could not be attended to. Probably no single item contributes more to the poverty of the agricultural classes than mortality among useful cattle, much of which would be preventible if adequate veterinary assistance were at hand, whether for inoculation, vaccination, or treatment.

## II. Incidence of Disease.

*Bombay.* The total number of reported deaths amongst cattle from contagious diseases dropped to 7,752 in 1920-21 from 8,647 of the previous year. There was also a comparative decrease reported in the mortality from rinderpest, but enquiries made by the officers of the department in selected areas showed that the figures supplied by village officers were not to be relied upon as evidence that the year had been a healthy one. In fact the cattle plague was particularly widespread especially in the Northern and Central Divisions, the districts suffering most being those into and through which famine-striken cattle were moved. The other contagious disease which was prevalent in all the districts was the foot-and-mouth.

*Madras.* The year appears to have been a comparatively healthy one for stock, the recorded number of deaths from contagious diseases being 37,066 against 59,297 in the preceding year. The decrease in the mortality from rinderpest was

particularly marked. Seven cases of surra were confirmed microscopically, and 14 cases of *kumri* were detected by the staff.

Pleuro-pneumonia of sheep was again responsible for heavy mortality at the Bantanahal farm. As the organism of hæmorrhagic septicæmia was found in the heart blood of some of the sheep after death, all the animals at the farm were inoculated against this disease. The cattle quarantine depôt at Tuticorin was transferred during the year, at their own request, to the Ceylon Government.

*Bengal.* Contagious diseases were responsible for 19,344 deaths compared with 14,898 reported in the preceding year. Rinderpest as usual was responsible for the greater of this mortality, *viz.*, 17,425 deaths. Although these figures may at first sight appear to be high for the year, it is pointed out that with the increasing facilities for reporting outbreaks, many more come to light than in past years. For example, in the Burdwan Division, where many union veterinary associations have been organized, 144 more reports of outbreak were received than in the previous year. There was a substantial reduction in death-rate from hæmorrhagic septicæmia and other contagious diseases.

*Bihar and Orissa.* The comparative mildness which characterized the outbreaks of contagious diseases of cattle in 1919-20 was more than counter-balanced during the year under review, the number of deaths during the two years being 15,781 and 29,204, respectively. Continued improvement in collecting the statistics is, as in the case of Bengal, said to have contributed to the increase in the figures. Rinderpest alone accounted for 24,592 deaths out of 60,159 animals attacked in 2,954 outbreaks.

*United Provinces.* There was a general decrease in the number of deaths from contagious diseases, the total mortality being 19,502 as against 42,715 in the previous year. The most striking reduction was in the case of rinderpest, *viz.*, from 32,572 in 1919-20 to 15,296 during the year under review. Surra appeared only in the district of Garhwal where six animals either succumbed or were destroyed under the Glanders and Farcy Act.

*Punjab.* There were only 25,200 reported deaths from contagious diseases as against 56,089 of the preceding year. This remarkable decrease in mortality is attributable to the dry season. The percentage mortality among cases of attack, however, was relatively high this year, owing to the generally poor condition of the animals affected. Surra was less widespread than in the previous year, and no case of dourine was reported for the second year in succession. This is satisfactory testimony to the efficacy of the thorough measures taken to suppress the disease in 1919. There was a serious outbreak of contagious abortion among the pony and donkey mares on the Hissar farm, and it may be advisable to stop equine breeding operations on the farm for a period. Thirty-two cows and two sheep died of anthrax on the Hissar farm. The disease had not previously been detected on the farm since the Civil Veterinary Department took it over in 1899.

*Central Provinces.* The year was an unhealthy one for live stock and there was a considerable increase in the number of deaths reported from contagious diseases, the figures rising from 20,819 in 1918-19 and 33,052 in 1919-20 to 46,243 in the year under review. Scarcity of fodder and water which existed in several localities with the resultant lowered vitality and inability to throw off disease were perhaps responsible for the increase in the death rate. Rinderpest was widespread, took a virulent form in several districts, and accounted for as many as 41,725 deaths.

*Assam.* The mortality from contagious diseases rose from 39,188 in the preceding year to 47,083 in 1920-21. The heaviest loss was due mainly to rinderpest which was reported from all districts and caused 20,887 deaths against 17,443 in 1919-20. There was also a decided increase in the mortality from the foot-and-mouth disease, the figures for the two years being 5,433 and 3,271, respectively. There were only 30 total cases of surra, which were less than half of what occurred in the preceding year.

*Burma.* The total number of deaths from contagious diseases dropped to 40,409 in the year under review from 59,425 of the previous year. Rinderpest, the principal contributory cause, was particularly mild in Lower Burma, but it

levied a heavy toll in Upper Burma where lack of water and under-feeding brought about by three successive bad seasons had rendered the cattle an easy prey to attacks. The Shan States were singularly free from cattle disease, and only 63 deaths from rinderpest were reported to have occurred.

*North-West Frontier Province.* Owing to the dryness of the season the year was a very healthy one for cattle: there were only 1,067 deaths as compared with 3,087 in the preceding year. Out of 940 deaths among bovines, rinderpest accounted for 640. Surra was prevalent in the Karram and Malakand Agencies, especially in the former, and was responsible for nearly two-thirds of the total fatal cases.

*Sind.* Rinderpest broke out with considerable virulence in all districts except Karachi, with the result that the mortality from all contagious diseases rose to 10,564 from only 1,688 of last year, the cattle plague alone being responsible for 8,273 deaths. Forty-five cases of glanders and 91 of surra were reported; all the animals died or were destroyed under the Glanders and Farcy Act. The veterinary charge of Sind having been separated from that of Baluchistan and Rajputana, appreciable improvement in control of disease may be expected in all three provinces.

*Baluchistan.* The number of reported deaths from contagious diseases was 4,685 as against 3,277 in the preceding year. Rinderpest was more widespread and was specially rife in the Sibi and Loralai Districts with the result that 3,329 animals succumbed to it compared to only 1,237 in 1919-20.

*Rajputana.* The total mortality from contagious diseases was reported to be 256 against 252 last year. One hundred and forty animals died of rinderpest.

## III. Preventive Inoculation.

The Imperial Bacteriological Laboratory at Muktesar, which supplies the munitions of the campaign against contagious diseases of cattle, issued 25,20,867 doses of different sera and vaccines to the provincial Veterinary Departments from which 8,56,583 animals were inoculated during outbreaks. There were only 3,789 deaths or just over 0·4 per cent. among inoculated cattle. In the preceding year it was not possible in

some cases to supply the quantity of serum asked for, but the reorganization of the serum-making department at Muktesar resulted in meeting all demands during the year under review. The following table compares the doses issued during 1920-21 with the average of the previous five years :—

| | 1920-21 | Average of 1915-16 to 1919-20 |
|---|---|---|
| Rinderpest serum . . . . | 3,126,136 | 2,104,398 |
| Anthrax serum . . . . | 31,613 | 29,864 |
| Hæmorrhagic septicæmia serum . | 106,528 | 135,627 |
| Do. do. vaccine . | 126,200 | 124,734 |
| Black Quarter . . . . | 30,900 | 20,048 |

It is evident that the maximum of output of Muktesar even when the full effects of the recent reorganization have been realized will not long be sufficient to cope with the growing popularity of its products, and the question of starting a similar laboratory in South India is under consideration. At the same time the advantage of establishing a few cold storage centres in the provinces is apparent, so that at times of urgent demand the isolated position of Muktesar may not act as a handicap in obtaining immediate supplies.

The serum alone method of inoculation against rinderpest has been accepted as the best for India on account of its simplicity and absolute safety. The only claim made for it is that it carries an animal through an outbreak, and that it does so will be manifest from the fact that while the normal mortality from this scourge is 75 per cent., the actual deaths amongst the 785,000 animals inoculated with anti-rinderpest serum amounted to only 0·55 per cent. Outbreaks of cattle plague will neither be less frequent nor less virulent than before until compulsory inoculation, isolation and disinfection are introduced. But the time for such legislation appears to be still distant. It is also not yet possible to initiate on a large scale "serum simultaneous" method. How much is possible even

with the "serum alone" method, if people will only co-operate with the department, is well illustrated by the following remarks of the Sub-divisional Officer of Prome in Burma:—

> The low mortality this year is due to prompt information of the outbreak of cattle disease, the immediate visit of the Assistant to the spot affected, and the help and co-operation of the headmen in enforcing the segregation and cattle disease rules. The disease in most cases was localized and stamped out before it could spread to the neighbouring villages.

Unlike rinderpest, hæmorrhagic septicæmia is not infectious but contagious; consequently, in its outbreaks, nothing like the same number of animals is affected and hence the number of inoculations against it is smaller. Outbreaks of this disease also subside quicker than is the case with rinderpest; naturally the necessity for anti-serum inoculation is not so frequent. Of the 43,000 animals inoculated against this disease with serum, only 0·04 per cent. died; while the 51,841 vaccinated bovines had not a single death among them. The practice which has been adopted in the Punjab of regularly carrying out every year before the rainy season the vaccination of animals in low-lying villages liable to visitations of this disease is finding favour with cattle owners in these areas. The extension of such preventive measures will depend on the staff available, as to gain the maximum advantage it is necessary to complete the work within a short period before the breaking of the rains.

Anthrax and Black Quarter are other contagious diseases against which prophylactic measures are taken on some scale. Results of injections made during the year indicate that the mortality among inoculated animals do not exceed 0·17 and 0·31 per cent., respectively.

In Madras, the Cattle Disease Act was enforced at all important annual cattle fairs. The Act makes it obligatory on the keeper of the hospital pound to impound every animal found to be suffering from a contagious or infectious disease. In certain cases, however, it has been found impracticable to impound all such animals, and in the case of a disease like rinderpest it is desirable to avoid movement as far as possible. To remedy this defect in the law, the local Civil Veterinary

Department proposed certain amendments so as to give discretion to the keeper of the hospital pound in the matter of impounding animals and Government have brought in a bill during the year to amend the Act accordingly. The rules framed for the quarantining of cattle imported from other countries came into force during the year. The object of the rules is to prevent the importation of tuberculosis into this country.

## IV. Veterinary Education.

For the training of students in veterinary science, there are colleges at Bombay, Madras, Calcutta and Lahore, and schools at Insein and Taunggyi in Burma.

The colleges at Bombay, Madras and Calcutta give a three-year diploma course in English, while at Lahore Urdu is the medium of a similar course of study. As stated in last year's report, a four-year course in English is to be introduced at the Punjab Veterinary College. The total number of students who passed the final examinations of the colleges during 1920-21 was 130 as against 153 in the preceding year (Appendix VI, p. 105).

Owing to the deputation of some members of the staff for training in other branches of work no post-graduate classes were held at Lahore, but ten Veterinary Assistants from Assam went through a post-graduate training at the Bengal College. Eighteen officers, including 14 from the R. A. V. C., attended short courses of instruction at the Imperial Bacteriological Laboratory, Muktesar.

Seven dressers and 16 farriers were trained at Lahore, while at Calcutta 60 students of the public health class were trained in the diseases of animals transmissible to human beings, 34 students under training as sanitary inspectors were given a course of lectures and demonstration of infective diseases of animals, two transport drivers were trained as veterinary dressers and one man from the Bengal bodyguard was given instruction in horse-shoeing. Two students passed out during the year from the veterinary compounders' class attached to the Nagpur hospital.

The veterinary schools at Insein and Taunggyi give vernacular courses of three years and a year and a half, respectively.

The number of students who passed the final examinations of these schools during 1920-21 was 18 and 5, respectively. The training given at these schools hardly meets the requirements of Burma and the question of a well equipped college will shortly have to be taken up.

The scheme for establishing a veterinary college for the United Provinces has well advanced, and estimates and plans are in course of preparation.

The provision of higher veterinary training for students who will be qualified for appointment to the higher grades of the Provincial Service or ultimately to the Imperial Service either by opening a higher grade college or by raising the standard at one or more selected colleges or by sending suitable candidates on stipends to foreign institutions is engaging the attention of the Government of India.

The United Provinces Veterinary Medical Society continued to do good work and a well attended and successful meeting of its members was held at Benares. An Urdu Veterinary Journal is published monthly by the Society. In Bengal, veterinary union committees are being organized in India District and in the Burdwan Division to co-operate with veterinary officers in the matter of combating outbreaks of cattle diseases and the improvement of cattle in general, and the results are very encouraging. Leaflets dealing with prevention and treatment of cattle diseases, were, as usual, freely distributed, and lectures on animal diseases, hygiene, cattle-breeding, cultivation of fodder, etc., given to cultivators and stock owners congregated at fairs and shows.

## V. Veterinary Research.

*Rinderpest.* The following experimental work taken in hand at Muktesar during the year will shortly be published :—

(1) The preparation of anti-rinderpest serum using animals of moderate susceptibility as virus producers.

(2) A further investigation into the duration of the immunity conferred by serum alone.

(3) An investigation into the nature of the immunity conferred by very large doses of serum when given simultaneously with a dose of virulent blood.

(4) The elaboration of a special apparatus for bleeding the virus producers and injecting the serum producers for use in large scale rinderpest serum production.

*Bovine tuberculosis.* The results of the experiments carried out at Muktesar with the material received from the Ferozepur slaughter-houses were issued in a Memoir (*Vet. Series*, III, 2). They appear to indicate beyond all possibility of doubt that the strains of tubercle bacilli infecting cattle in India possess a distinctly lower degree of virulence than tubercle bacilli isolated from cattle in Europe. In practically every instance in which the natural lesions came under observation they were found restricted to a few glands and calcified to a very large extent.

*Bovine lymphangitis.* Experimental work started by Mr. Sheather with material received from Madras showed that it was possible to reproduce the disease in plains calves to the extent that subcutaneous inoculation with pus taken from natural cases led to the formation of an abscess and suppuration of the nearest lymphatic gland. The results are embodied in *Vet. Mem.*, III, 3.

*Equine contagious abortion.* Experiments were carried out at Muktesar by Mr. Doyle with a bacillus obtained from aborted foetuses at the Government Cattle Farm, Hissar, which proved to be the *Bacillus abortivo equinus.* An account of this work will be issued shortly .

*Surra.* A large number of experiments were carried out with tartar emetic treatment by Captain Cross, Camel Specialist. The percentage of cures was above 70. It has been ascertained that treatment should not be commenced when trypanosomes are present in the peripheral circulation and the temperature is high, and that doses of 150 and 200 c. c. of 1 per cent. solution are usually well tolerated. Fifty-two military camels suffering from surra were treated in this manner and returned to duty in excellent condition. The work hitherto carried

on at Sohawa gives considerable promise of success, and this year it is proposed to extend it so that definite conclusions regarding the efficacy of tartar emetic as a cure for surra can be arrived at. About 90 experiments were also carried out with different species of Tabanidæ to ascertain the transmitting agent of surra, and whether surra is spread by direct transmission or whether there is a cyclical development in the transmitting agent. No definite conclusions have been arrived at. In connection with the transmission of surra, a fly survey of various main roads and other areas in North-West India is in progress.

*Mange.* Attempts are being made at Sohawa to ascertain the best treatment of mange. Hitherto good results have been obtained by the application of *taramira* oil. As soon as a camel dip is erected, it is proposed to ascertain the efficacy of calcium sulphide compared with that of other dressings.

*Spirochætosis of fowls.* Captain Cross's investigations show that if the poultry were treated in the early stages of the disease by injections of soamin, enormous losses occurring from it could be avoided.

## VI. Breeding.

(*a*) ***Cattle-breeding.*** The admittedly unsatisfactory state of the cattle question in India is probably mainly due to the gradual rise in population and the rate of wages, with it an increased demand for foodstuffs involving a corresponding decrease in areas devoted to grazing and to raising of fodder crops. The question is in fact suffering through one of those large economic changes which finally do adjust themselves but bring along with them serious disadvantages many of which (reduction in size, for example) will no doubt remain more or less permanent. There is, however, plenty of room for a well thought out policy of cattle-breeding, as the economic situation has brought with it tendencies to deterioration which can be satisfactorily dealt with by breeding and organization. The rise in the price of working cattle has, for instance, raised the value of a good bullock above that of a stud bull with a tendency towards the castration of the best animals. Increased breeding in the arable areas is now an imperative necessity but there

is a great lack in many places of stud bulls for this purpose. Again the drain of the best milk cattle into the towns and the consequent loss of these for breeding purposes has all but ruined the milk breeds of the country.

The cattle-breeding operations in progress have thus a wide field of application. A very large development will, however, be necessary to meet the demand for stud bulls which will undoubtedly arise from successful breeding on the Government farms.

At *Pusa*, cattle-breeding has been directed mainly along two lines :—

(1) The grading up of a country milk breed.

(2) Experiments in cross-breeding with imported cattle of high milking pedigree with the primary object of obtaining reliable information regarding the inheritance of the observable characters of both breeds.

As explained in previous Reviews, the Punjab Montgomery cattle have been used as a representative country milk breed for grading experiments and also as the female parent for cross-breeding. The main result of general interest is an undoubted confirmation of the view, based on the experience with the first generation of cross-bred cows, that success in breeding milk animals depends mainly on the hereditary qualities transmitted through the male parent. In all attempts, therefore, to build up from the beginning a strain of milk animal of a particular breed, it is necessary, at the outset at any rate, to use as large a number of bulls as possible and to keep representatives of their male progeny until the females have been tested for milk yield. It may also be possible that in the popularly accepted non-milk breeds sires possessing the milk quality may be unearthed by testing the progeny of a large number of animals.

The scheme for breeding Dhanni bulls, by subsidising private breeding operations, instituted in 1919 by the *Punjab* department has had a difficult (on account of fodder shortage) but on the whole a successful year. Forty-two selected bulls are now at stud in the three districts of Attock, Jhelum and

Rawalpindi in which the scheme has been started, and their services have been fully utilized.

A record number of bulls, *viz.*, 239, were issued from the Hissar farm to the districts this year, inspite of the severe shortage of fodder which made it necessary for District Boards to considerably curtail their indents. The total number of bulls at stud during the year was 1,440. The total receipts of the farm amounted to Rs. 2,02,501, a record figure. The highest price realized for a pair of bullocks was Rs. 650.

The five grantees for cattle-breeding in the Lower Bara Doab Colony are on the whole doing well, and the grantee for a dairy farm near Montgomery having returned from England after training has been put in possession of land. A similar grant, to suitable persons, to improve the milk supply of Lahore city is under consideration.

In the *North-West Frontier Province*, 54 bulls belonging to local bodies were at stud during the year as compared with 38 last year. Dhanni bulls now seen at various fairs in the province are of a distinctly better class, with the result that cattle owners now show a general desire to have the services of these animals. With a view to assist in maintaining the purity of the breed of the Montgomery cows imported into the province, it is proposed to keep at least one good bull of this breed at the headquarters of each district. The Awankari herd at Tarnab is making good progress.

In the *United Provinces*, there are two bull-rearing and breeding farms. The one at Manjha deals with the well-known local Kherigarh breed, and the other at Madhurikund in the Muttra District exists for the improvement of the Hariana breed. The former farm issued 28 Kherigarh stud bulls during the year, while eight animals were sent out from the latter. In all there are now 310 animals at stud work in the province. Now that the post of Deputy Director for developing cattle-breeding operations has been filled, these two farms will be transferred to the Agricultural Department.

Results obtained at the Rangpur cattle farm, which was started to ascertain whether it would be possible to raise improved cattle in *Bengal* instead of depending on importation

from upcountry as is the present practice, are distinctly promising. Both *deshi* and imported Hansi bulls are used on indigenous cows on this farm, the half-bred Hansi bulls showing distinct signs of improvement over any local cattle. The grading up of the local mongrel stock is not likely to be possible through simple selection from Bengal animals.

A small dairy herd of red Sindi cattle has also been started in connection with the Dacca Agricultural School.

An outbreak of black quarter at Sipaya and want of funds to feed the cattle properly at Sabour were unfortunate incidents in the *Bihar* operations. The abnormal dearth of fodder throughout Chota Nagpur brought about considerable reduction in the milk yield of the Naterhat herd, but the success attained at Ranchi with Pusa Montgomeries in increasing the average yield inspite of famine conditions was noteworthy.

*Assam.* The Upper Shillong herd of pure Patna and Patna-Bhutia cross-bred cattle is showing promising results, and the demand for Patna animals still far exceeds the supply. The department proposes to start a cattle farm of 300 acres on Government waste land somewhere in the Kopili valley as soon as administrative sanction is granted.

Bulls of five distinct breeds are being reared on eight cattle-breeding farms in the *Central Provinces* for sale to cattle-owners interested in breeding. The demand for these bulls has never been keen for the simple reason that few cattle-owners have herds large enough to afford the maintenance of a good bull. To get over this difficulty, a scheme for subsidising owners who are willing to keep stud bulls for the common good has been approved of and will shortly be put into force. The local breeds are, however, such poor milkers that it does not pay as a rule to rear animals, and the mere supply of good bulls is not likely to encourage cattle-breeding. Experiments in crossing cows of the local Gaolao breed with bulls of such excellent milking strains as the Ayrshire and Montgomery have therefore been in hand for some time, and have given interesting and reliable results. The cross-bred Gaolao-Montgomery cows give twice as much milk as do those of the local breeds, and the bullocks are distinctly bigger and stronger. The Gaolao-Ayrshire cows have

also proved to be good milkers, but the bullocks of this cross are not likely to prove so useful as those of the Montgomery strain. In all, 142 animals, including 18 bulls, were sold out from the farms during the year under review.

In *Bombay*, cattle-breeding operations consist chiefly of efforts to maintain and improve the chief breeds of the presidency. So far the Agricultural Department has been able to establish two farms for this purpose, one at Chharodi in Gujarat for the famous Kankreji breed and the other at Bankapur for the Mysore breed. The former farm which has now been in existence for over 20 years is said to possess the finest collection of typical Kankreji animals in India and is being increasingly drawn upon for breeding bulls for the villages. Efforts to improve the Kankreji and Sindi animals as milkers are being carried on at Chharodi and Poona, respectively, where all but the best milk stock are being eliminated, and it is hoped to be able shortly to distribute a limited number of bulls derived from known good milking strains. Now that the department has got a full time officer to look after animal-breeding operations, the policy of establishing breeding herds of the finest types of animals for each of the great breeds of the presidency will be rapidly developed.

The question of keeping the existing cattle alive through periods of famine is just as important as that of maintaining and improving the breeds. This question has by no means been neglected, and the experience and example of the Bombay department should be useful to others. The scheme initiated by Mr. Keatinge, late Director of Agriculture, sometime ago of storing grass and *kadbi* (dried *juar* stalks) in a portable form in good years for use in periods of scarcity has not only been found useful but has proved financially successful. During the recent famine in Ahmednagar District, $3\frac{1}{2}$ lakhs of lb. of first class dry fodder were issued from the Kopergaon depôt. A similar depôt will this year be established in the Dharwar District. During the past year, the Bombay department also undertook the control of famine cattle camps, and they were successful in carrying through large numbers of cattle which would otherwise have died through the most trying periods of the year,

and in selling these in good enough condition to do the usual season's work.

In *Madras*, the cattle-breeding operations aim for the present at the production of a number of good type Ongole bulls for distributing them with the object of the maintenance and improvement of the breed generally, the improvement of country buffaloes, and the improvement of the Madras milk supply. The last problem is being attacked along three lines, *viz.*, the production, by cross-breeding, of a type of animal with the constitution of the indigenous breed and the milking qualities of the Ayrshire, grading up the local animal by placing at stud Ayrshire bulls, and improving the economic position of the milkmen by introducing them to co-operative methods. It is proposed to start a dairy farm at Guindy for conducting the breeding experiments which are at present carried on in conjunction with the Bangalore military farm authorities.

The control of the new palace dairy in *Mysore* having been entrusted to the Agricultural Department, a much wider field for work in the improvement of dairy cattle has been ensured than did the small dairy at Hebbal. An initial herd of Sindi cows has been obtained from Karachi, and two Holstein bulls of the very best milking strain have been ordered from America. For the improvement of draught cattle, selected breeding bulls are kept for service at veterinary hospitals. The practice of travelling these bulls in the surrounding localities is being given a trial and so far has been successful.

(*b*) ***Sheep-breeding.*** Experiments are in progress in several provinces to grade up the indigenous sheep by cross-breeding with Merino and other strains. Results hitherto achieved are by no means discouraging so far as wool is concerned, although considerable difficulty will always be felt in combining weight of wool with carcase production. Climate and disease are the two factors which militate against the success of cross-breeding experiments, but it is hoped that the graded up progeny will acquire from the native parent or grandparent a degree of immunity to the effects of climate and to certain epizootic and parasitic diseases to which the imported strains are liable.

There are now various generations of Merino crosses on the Government sheep runs in the *United Provinces*, and in every case the progeny is superior in wool quality to the parents. The best animal so far produced is the seven-eighth Merino cross, but the excellence of the wool has been gained at the expense of mutton carcase and constitution. It has been found necessary to introduce mutton qualities and great robustness into the flock, and for this purpose it is proposed to mix the breed with Romney Marsh or Leicesters from Australia.

Cross-bred Merinos to the number of 60 rams and 137 ewes were purchased by private individuals for breeding purposes from the Hissar farm in the *Punjab*, and these were sent to Ferozepore, Shahpur, Hissar, Multan, Gujarat, Jullundur and Sheikhupura Districts. It is a pity that the demand for ram lambs is not so keen as that for ewes, as the increased issue of the former would have a greater effect on indigenous flocks than that of the latter. The Merino cross is, however, making a certain amount of progress in the districts in the hands of owners who take an interest in their flocks. The problem of securing for the small owner the fair market value of his wool can only be dealt with on a co-operative basis; its solution would make for the popularity of the Merino more than any other factor.

In the *North-West Frontier Province*, the cross-bred progeny from the local Hashtnagri ewes and fat-tailed Pusht-i-kuh rams show a general improvement of both fleece and mutton, but permanent results will necessitate careful breeding for some years to come.

In *Mysore*, hybrid Merino sheep have been found to give an average of 2 lb. 10 oz. of wool against an average of 1 lb. per head for the country ewes which in turn have been specially selected for their fleece.

## CHAPTER IX.

## PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

***Imperial.*** The Imperial Department of Agriculture in India issued 27 memoirs, 6 bulletins and 2 indigo publications during the year, while over 40 publications were in the press on the 30th June, 1921.

The Report of the Proceedings of the Third Entomological meeting, which was in the press in the beginning of the year, the Proceedings of the Second Meeting of Agricultural Chemists and Bacteriologists and those of the Third Meeting of the Mycological Workers in India, held in February 1921, were published during the year, while the Report of the Proceedings of the Fourth Entomological meeting was in the press on the 30th June, 1921.

*The Agricultural Journal of India* continued to gain in popularity, especially among the zemindar classes.

***Provincial.*** The *Bengal* Department of Agriculture started a quarterly agricultural journal with a view to giving wider publicity to the work of the department and to encourage the spread of agricultural knowledge.

In the *United Provinces*, the agricultural journals (1) *Mufid-ul-mazarin* in Urdu and (2) *Kisanupkarak* in Nagri were regularly issued. In spite of the agrarian troubles the circulation of these journals has increased.

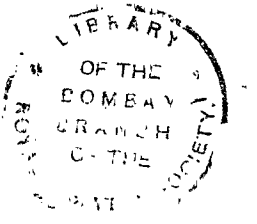
In *Bombay*, 5 bulletins and 5 leaflets on cotton, groundnut, paddy, etc., were prepared for publication. The *Poona Agricultural College Magazine* continued to issue.

In *Madras*, 1 bulletin and 3 leaflets were issued. The "Year Book" covering both 1920 and 1921 was in the press at the end of the year, while 18,500 copies of the Villagers' Calendar, 1920-21, were printed in English, Telugu, Tamil, Kanarese and Malayalam and were distributed by the Publicity Officer.

In the *Central Provinces*, nearly 15,000 copies of Mr. Clouston's book entitled " The Story of Rai Saheb Kaluram Kurmi " were sold up to the end of the year under review. A report on the cattle survey for the cotton tract is in the press. A similar report for the north of the province is under preparation.

The *Burma* Department of Agriculture issued 2 bulletins and 1 leaflet. In addition, Mr. Chalmers' note on " Coconuts in Madras " was printed and widely circulated. It was also translated and published in *Burma's Progress*.

A complete list of agricultural publications in India issued during the year under review is given as Appendix VII (p. 106).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## CHAPTER X.

## EXPENDITURE OF THE AGRICULTURAL DEPARTMENTS.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year ending 31st March, 1921, was Rs. 9,84,553 as against Rs. 6,59,343 during the previous year, an increase of Rs. 3,25,210 debitable mainly to capital expenditure for which a grant of Rs. 2,52,000 was sanctioned out of the imperial grant of 15 lakhs for agricultural education. The details are given below :—

| | Rs. |
|---|---|
| General expenditure of the Institute (including Office of the Agricultural Adviser and Director) | 3,38,044 |
| Chemical Section | 60,262 |
| Mycological Section | 62,267 |
| Entomological Section | 69,632 |
| Pathological Entomological Section | 29,233 |
| Bacteriological Section | 54,111 |
| Botanical Section | 45,205 |
| Agricultural Section (including cost of new area) | 2,44,307 |
| Indigo Research Section | 50,827 |
| Protozoological Section | 25,268 |
| Physiological Chemical Section | 5,397 |
| TOTAL | 9,84,553 |

A sum of Rs. 15,000 was paid as grant-in-aid to the Indian Tea Association.

The principal items of expenditure under the annual grant of Rs. 10,000 placed at the disposal of the Agricultural Adviser to the Government of India for special agricultural experiments were as follows :—

| | Rs. |
|---|---|
| Apparatus for the Chemical Section | 1,690 |
| Kinematograph, agricultural demonstration | 350 |
| Materials for fitting up a new laboratory for the Imperial Agricultural Chemist | 1,812 |

| | Rs. |
|---|---|
| Removal of pumping engine | 979 |
| Experimental cotton cultivation by the Imperial Cotton Specialist, Poona | 1,000 |
| Mosquito experiments | 469 |
| Pay of a surveyor | 214 |

The expenditure incurred on the working of the Imperial Bacteriological Laboratory at Muktesar during the period was Rs. 6,58,409 as against Rs. 5,00,510 in the previous year. The principal items were as follows :—

| | Rs. |
|---|---|
| Salaries and travelling allowances of officers and staff | 1,21,114 |
| Feed and keep of animals | 3,47,925 |
| Cost of chemicals and apparatus | 34,880 |
| Purchase of animals | 64,326 |
| Miscellaneous expenditure | 90,164 |
| TOTAL | 6,58,409 |

The total expenditure which the Provincial Departments of Agriculture incurred during the year amounted to Rs. 89,17,785 as against Rs. 71,71,025 during 1919-20. The details are given below :—

| | Rs. |
|---|---|
| Bengal | 9,07,446 |
| Bihar and Orissa | 4,69,612 |
| United Provinces | 14,63,199 |
| Punjab | 17,78,058 |
| Bombay | 16,09,000 |
| Madras | 12,71,158 |
| Central Provinces | 7,22,926 |
| Burma | 3,77,712 |
| Assam | 2,39,840 |
| North-West Frontier Province | 50,433 |
| Baluchistan | 28,401 |
| TOTAL | 89,17,785 |

## APPENDIX I.

*Areas under new and improved varieties of crops during the year 1920-21.*

| Province | Name of crop | Area in acres | Advantages | Remarks |
|---|---|---|---|---|
| Bengal | Paddy (*Kataktara, Indrasail* and *Nagra*). | 46,700 | The yield is 3 to 6 maunds more per acre than the local varieties. | Areas shown here are mainly those sown with seed issued through departmental sources, but natural spread has been taken into consideration in few instances. |
| | Groundnut | 1,291 | Worthless, sandy waste tracts are yielding handsome profits through the introduction of this crop. | |
| | Wheat (Pusa 12) | 199 | Has good milling qualities. | |
| | Sugarcane (*Tanna*) | 408 | Not so subject to diseases and pests or damage by wild animals as local varieties. Yields 6 to 12 maunds of more *gur* per acre. | |
| | Jute (green *olitorius, Kakya Bombai*, R 85 and R 26) | 55,280 | Give 3 to 6 maunds of more fibre per acre and fetch Rs. 2 to Rs. 3 more per maund than local varieties on account of finer fibre. | |
| Bihar and Orissa | Groundnut | 425 | Suitable to be cultivated in waste lands and in comparatively poor soil at a small cost. | Correct figure as to the area under the crop is not available. About 25 acres were cultivated under direct supervision of the department. |
| | Wheat (Pusa 12) | 2,000 | More prolific under irrigation and yields about 25 per cent. more than the local variety. | |
| | Exotic sugarcanes (Java) | 8 | Yield 80—100 per cent. more than local cane. | |

*Areas under new and improved varieties of crops during the year 1920-21*—contd.

| Province | Name of crop | Area in acres | Advantages | Remarks |
|---|---|---|---|---|
| Bihar and Orissa—*concld.* | Sugarcane (*Mungo* variety) | 110 | A hard, thin cane, is immune from the attacks of jackal and wild boar and is more resistant to drought than the local varieties. The quality of *gur* is also superior. | It is impossible to give correct figures as to the area under this crop. About 110 acres were cultivated under direct supervision of the department. |
| | Paddy (*Indrasail*) . . | 10 | A very heavy yielder. | |
| United Provinces . | Wheat (Pusa 4 and 12, C 13) | 400,000 | Better yielders than local varieties. | |
| | Cotton (Ca, Jn 1, K 22) . | 200,000 | In yield, staple and ginning percentage much superior to local varieties. | |
| | Sugarcane . . . | 5,000 | Yields more *gur* per acre than local varieties. | |
| Punjab . . | Wheat (Punjab 11) . . | 601,384 | Yields more than local varieties and gives more profit per acre to the cultivator. | |
| | Cotton (4 F) . . . | 513,791 | Competes favourably with indigenous varieties where soil and water conditions are favourable. Has a finer staple and fetches higher price than *deshi* cottons. | |
| | Cotton— | | | |
| | I A . . . . | 7,231 | The lint of IA is sold at a premium of Rs. 40 per *candy* of 784 lb. over that of local varieties, and that of 1027 A L F at a premium of Rs. 58. | |
| | 1027 A L F . . | | | |
| | Dharwar I . . . | 13,417 | Give an average profit of Rs. 4 and Rs. 11 per acre to the cultivator respectively. | |
| | Gadag I . . . | | | |

| | | | | |
|---|---|---|---|---|
| Bombay | 4 F American | ... | Is a better yielder and has a longer staple than *deshi*. Is more resistant to drought. Gets a premium of Rs. 3 per maund over ordinary Sindhi lint. | Exact information about area is not available. |
| | Deshi strain 27 W N | | | |
| | Sugarcane (Red Mauritius) | 475 | Gives higher yield of cane and juice than the local varieties, is less liable to lodging, and is immune to red rot. It has a hard rind and is not damaged by jackals. | |
| | Groundnut | 1,741 | Is suitable for poorer land. | |
| Madras | Paddy | 6,000 | Better yielders than local varieties and more profitable to cultivators. | |
| | Sugarcane | 3,250 | | |
| | Cotton | 68,500 | | |
| Central Provinces | Paddy | 77,200 | Gives an increased profit of Rs. 4 to Rs. 20 per acre over local varieties. | |
| | Wheat | 801,455 | Gives an increased profit of Rs. 2 to Rs. 13 per acre over local varieties. | |
| | Sugarcane | 831 | Gives an increased profit of Rs. 25 to Rs. 100 per acre over local varieties. | |
| | Cotton | 363,370 | Gives an increased profit of Rs. 4 to Rs. 14 per acre over local varieties. | |
| | Groundnut | 4,890 | Gives a higher return of Rs. 15 to Rs. 20 per acre. | |
| | *Juar* | 44,000 | Gives a higher return of Rs. 5 to Rs. 10 pr acre. | |
| | *Til* | 75,000 | Gives a higher return of Rs. 2 per acre. | |
| Burma | Paddy | 85,825 | Better yielders and more profitable to cultivators | |
| | Cotton | 498 | | |

*Areas under new improved varieties of crops during the year 1920-21*—concld.

| Province | Name of crop | Area in acres | Advantages | Remarks |
|---|---|---|---|---|
| Burma—*concld.* | Sugarcane | 746 | Better yielders and more profitable to cultivators. | |
| | Wheat | 2,123 | | |
| | Groundnut | 168 | | |
| | Linseed | 150 | | |
| | Gram | 190 | | |
| Assam | Paddy | 508 | On an average gives increased outturn of 213 lb. per acre over local varieties while in some cases the yield has been 1,200 lb. more per acre. | |
| | Potatoes | 220 | Higher yielders than *deshi* varieties. | |
| | Jute | 1,520 | | |
| | Sugarcane | 20 | | |

## APPENDIX II.

*List of Agricultural Stations in British India in 1920-21.*

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| | Pusa, Bihar | 550 | Overseer | Imperial Agriculturist, Agricultural Research Institute, Pusa. | Under the Imperial Department of Agriculture. |
| Bombay | Surat | 292 | Superintendent | Deputy Director of Agriculture, Gujarat, Surat. | |
| | Amalsad | 19 | Overseer | Ditto | |
| | Nadiad | 44 | Ditto | Ditto | |
| | Broach | 24 | Ditto | Ditto | |
| | Dohad | 57 | Superintendent | Ditto | |
| | Dhulia | 28 | Ditto | Deputy Director of Agriculture, North Central Division, Nasik. | |
| | Jalgaon | 214 | Ditto | Ditto | |
| | Kopargaon | 115 | Ditto | Deputy Director of Agriculture, South Central Division, Poona. | Mainly a fodder farm for famine use. (A small portion is utilized as a sugarcane station.) |
| | Baramati | 21 | Ditto | Ditto | Sugarcane farm. |
| | Dharwar | 134 | Ditto | Deputy Director of Agriculture, Southern Division, Dharwar. | |

*List of Agricultural Stations in British India in 1920-21*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bombay—*concld.* | Gadag | 50 | Superintendent | Deputy Director of Agriculture, Southern Division, Dharwar. | |
| | Gokak Canal | 62 | Ditto | Ditto | |
| | Tegur | 370 | Fieldman | Ditto | Cattle-breeding farms. |
| | Chharodi | 2,300 | Manager | Deputy Director of Agriculture for Animal Breeding, Poona. | Cattle-breeding farms. |
| | Bankapur | 112 | Ditto | Ditto | Cattle-breeding farms. |
| | Alibag | 72 | Superintendent | Deputy Director of Agriculture, Konkan, Ratnagiri. | |
| | Ratnagiri | 93 | Ditto | Ditto | |
| | Kumta | 184 | Ditto | Ditto | |
| | Karjat | 6 | Rice Specialist | Ditto | Rice research station. |
| | Karjat | 9 | Superintendent | Plant Breeding Expert, Poona. | Rice breeding station. |
| | Mirpurkhas | 200 | Ditto | Deputy Director of Agriculture, Sind, Karachi. | Seed farm. |
| | Mirpurkhas | 60 | Ditto | Ditto | |
| | Sukkur | 30 | Ditto | Ditto] | |
| | Larkana | 65 | Ditto | Ditto | |
| | Landhi | 24 | Ditto | Ditto | |

| | | | | | |
|---|---|---|---|---|---|
| | Jacobabad . . | 300 | Ditto . . . | Ditto | |
| | Ganeshkhind, Kirkee . | 80 | Ditto . . . | Economic Botanist, Poona. | Agricultural and botanical station. Horticultural course is given here. |
| | Modi Bag, Poona . . | 14 | Ditto . . . | Ditto | Teaching garden. |
| | Poona . . . . | 185 | Professor of Agriculture, Poona. | Professor of Agriculture, Poona Agricultural College. | Agricultural College farm. |
| | Kirkee . . . . | 362 | Manager . . . . | Ditto | Agricultural College dairy. |
| | Manjri . . . . | 62 | Superintendent. . . | Ditto | Sugarcane experimental station. |
| | Coimbatore . . . | 450 +42 | Manager . . . . | Superintendent, Central Farm, Coimbatore. | Central farm attached to the Agricultural College. |
| | Samalkota . . . | 57 | Ditto . . . . | Deputy Director of Agriculture, I Circle, Anakapalle. | |
| | Anakapalle . . . | 40 | Ditto . . . . | Ditto | |
| | Hagari . . . . | 224 | Ditto . . . . | Deputy Director of Agriculture, III Circle, Bellary. | |
| Madras | Bantanahal . . . | 819 | Ditto . . . . | Ditto | Sheep and seed farm. |
| | Sirvel . . . . | 44 | Ditto . . | Ditto | |
| | Nandyal . . . | 88 | Ditto . . . . | Ditto | |
| | Palur . . . . | 52 | Ditto . . . . | Deputy Director of Agriculture, IV Circle, St. Thomas Mount. | |
| | Gudiyattam . . | 18 | Ditto . . . . | Assistant Director of Agriculture, IV Circle, Vellore. | Demonstration farm. |

*List of Agricultural Stations in British India in 1920-21*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Madras—*concld.* | Koilpatti | 140 | Manager | Deputy Director of Agriculture, VI Circle, Madura. | |
| | Manganallur | 92 | Ditto | Deputy Director of Agriculture, V Circle, Trichinopoly. | |
| | Kasargod | 55 | Ditto | Deputy Director of Agriculture, VII Circle, Tellicherry. | West Coast coconut station. |
| | Anamalai | 40 | Ditto | Cotton Specialist, Agricultural College, Coimbatore. | Cotton farm. |
| | Taliparamba | 85 | Ditto | Deputy Director, VII Circle, Tellicherry. | |
| | Tenmalai (Travancore) | 20 | Ditto | Deputy Director of Agriculture, Planting Districts, Coimbatore. | Rubber stations. |
| | Mooply (Cochin) | 20 | Ditto | | |
| | Sidapur (Coorg) | 19 | Ditto | | Coffee station. |
| | Peermade (Travancore) | 20 | Ditto | | Tea station. |
| | Chintaladevi | 850 | Ditto | Deputy Director of Agriculture for Live Stock, Madras. | Cattle farm. |
| | Nanjanad, The Nilgiris | 90 | Overseer | Curator, Government Botanic Gardens and Parks, Ootacamund. | Seed potato farm. |
| | Coonoor | ... | Curator | Ditto | Pomological station. |
| | Dacca | 354 | Superintendent | Deputy Director of Agriculture, Eastern Circle, Dacca. | |
| | Mymensingh | ... | Ditto | | |
| | Comilla | ... | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| Bengal | Rajshahi | 63 | Ditto | Deputy Director of Agriculture, Northern Circle. | |
| | Rangpur | 333 | Ditto | | Cattle farm. |
| | Rangpur | 19 | Ditto | | Demonstration farm. |
| | Burirhat (Rangpur) | 52 | Ditto | | Tobacco farm. |
| | Bogra | ... | Ditto | | |
| | Chinsurah | 210 | Ditto | Deputy Director of Agriculture, Western Circle, Calcutta. | Private farms under the supervision of the Agricultural Department. |
| | Burdwan | 32 | Ditto | | |
| | Gosaba | ... | Ditto | | |
| | Kalimpong | 76 | Manager | ..... | Private demonstration farm managed by St. Andrew's Colonial Homes, with a subsidy from the Bengal Agricultural Department. |
| | Berhampur | ... | Superintendent of Sericulture. | Deputy Director for Sericulture | Sericultural research stations. |
| | Kurseong | ... | | | |
| | Kalimpong | ... | | | |
| Bihar and Orissa | Sabour | 190 | Superintendent | Professor of Agriculture | Home farm attached to the Agricultural College, Sabour. |
| | Dumraon | 30 | Ditto | Deputy Director of Agriculture, Patna Circle, Bankipore. | Private farm under the supervision of the Agricultural Department. Departmental control was withdrawn during May 1921. |
| | Ranchi (Kanke) | 140 | Ditto | Deputy Director of Agriculture, Chota Nagpur Circle. | |
| | Neterhat | 193 | Inspector | | Potato farm. |

*List of Agricultural Stations in British India in 1920-21*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bihar and Orissa—*concld.* | Purulia | 52 | Inspector | Deputy Director of Agriculture, Chota Nagpur Circle. | |
| | Ramgarh | 43 | Ditto | | |
| | Sambalpur | 32 | Ditto | | |
| | Cuttack | 150 | Manager | Deputy Director of Agriculture, Orissa Circle, Cuttack. | |
| | Khurda | 31 | Overseer | | |
| | Balasore | 80 | Ditto | | |
| | Angul | 25 | Ditto | Deputy Commissioner, Angul. | Private demonstration farm under the supervision of the Deputy Director of Agriculture, Orissa Circle. |
| | Sipaya | 379 | Superintendent | ..... | Cattle-breeding farm and sugarcane station. |
| | Cawnpore | 58 | Superintendent | | |
| | Kalianpur (Cawnpore) | 270 | Overseer | | Seed farm. |
| | Orai | 87 | Superintendent | | |
| | Altara | 171 | Divisional Superintendent of Agriculture. | | |

| | | | | | |
|---|---|---|---|---|---|
| United Provinces | Etawah | 50 | Superintendent | Deputy Director of Agriculture, Central Circle, Cawnpore. | |
| | Hardoi | 40 | Ditto | | |
| | Mainpuri | 52 | Inspector | | |
| | Jaitpur (Hamirpur) | 26 | Ditto | | |
| | Partabgarh | 90 | Superintendent | Deputy Director of Agriculture, Eastern Circle, Partabgarh. | Seed farm. |
| | Nagawan (Sultanpur) | 400 | Ditto | | |
| | Fyzabad | 206 | Ditto | | |
| | Benares | 78 | Ditto | | |
| | Aligarh | 88 | Inspector | Deputy Director of Agriculture, Western Circle, Aligarh. | |
| | Nawaganj (Bareilly) | 110 | Overseer | | |
| | Muzaffarnagar | 109 | Superintendent | | |
| | Muttra | 56 | Overseer | | |
| | Agra | 109 | Superintendent | | |
| | Saharanpur | 39 | Inspector | | |
| | Bulandshahr | 25 | Ditto | | |
| | Kalai (Aligarh) | 166 | Overseer | | Seed farm. |
| | Gorakhpur | 110 | Ditto | Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur. | |
| | Bahraich | 21 | Ditto | | |
| Punjab | Lyallpur | 614 | Manager | Deputy Director of Agriculture, 3rd Circle. | |
| | Montgomery | 250 | Extra Assistant Director of Agriculture. | Professor of Agriculture, Punjab Agricultural College. | Mainly a seed farm. |

*List of Agricultural Stations in British India in 1920-21*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Punjab—*concld.* | Gurdaspur | 161 | Manager | Deputy Director of Agriculture, 1st Circle. | Seed farms |
| | Sargodha | 157 | Ditto | | |
| | Chillianwalla | 250 | Ditto | | |
| | Hansi | 200 | Ditto | Deputy Director of Agriculture, 2nd Circle. | |
| | Kahuta | 558 | Extra Assistant Director of Agriculture. | Agricultural Chemist, Punjab. | For reclamation of saline soils. |
| Burma | Mandalay | 430 | Superintendent | Deputy Director of Agriculture, Northern Circle. | |
| | Padu | 29 | Overseer | | |
| | Nagu Plots | ½ | District Agriculturist | | |
| | Hopin | 33 | Overseer | | |
| | Yawnghwe | 36 | Superintendent | | |
| | Tatkon | 45 | Ditto | | |
| | Hmawbi | 432 | Ditto | Deputy Director of Agriculture, Southern Circle. | |
| | Nyaunglebin (Pegu) | 15 | District Agriculturist | | |
| | Yedasha (Toungoo) | 27 | Ditto | | |
| | Zigon (Tharrawaddy) | 20 | Ditto | | |
| | Thilawa (Hanthawaddy) | 53 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| | Pwinbyu (Mimbu) | 21 | Ditto | | |
| | Allanmyo (Thayetmyo) | 27 | Ditto | | Being extended by the acquisition of 115·83 acres. |
| | Taungtha (Myingyan) | 16 | Ditto | Deputy Director of Agriculture, Myingyan Circle. | |
| | Pakokku | 10 | Ditto | | |
| | Mahlaing (Meiktila) | 244 | Agricultural Assistant | | |
| | Nagpur | 268 | Superintendent | Principal, Agricultural College, Nagpur. | College farm. |
| | Akola | 271 | Ditto | Deputy Director of Agriculture, Western Circle, Nagpur. | |
| | Borgaon | 368 | Ditto | | |
| | Yeotmal | 106 | Ditto | | |
| | Khandwa | 177 | Ditto | | |
| | Basim | 109 | Ditto | | |
| Central Provinces | Sindewahi | 197 | Ditto | Deputy Director of Agriculture, Southern Circle, Nagpur. | |
| | Chandkhuri | 333 | Ditto | | |
| | Raipur | 229 | Ditto | | |
| | Tharsa | 116 | Ditto | | |
| | Wara-Seoni | 63 | Ditto | | |
| | Bilaspur | 253 | Ditto | | |
| | Drug | 281 | Ditto | | |
| | Telinkheri | 1,000 | Ditto | | Dairy farm. |

*List of Agricultural Stations in British India during 1920-21*—concld.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Central Provinces —*concld.* | Powarkhera (Hoshangabad). | 528 | Superintendent | Deputy Director of Agriculture, Northern Circle, Jubbulpore. | |
| | Adhartal (Jubbulpore) | 637 | Ditto | | |
| | Chhindwara | 69 | Ditto | | |
| | Betul | 161 | Ditto | | |
| | Seoni | 164 | Ditto | | |
| | Saugor | 161 | Ditto | | |
| | Damoh | 152 | Ditto | | |
| Assam | Jorhat | 59 | Manager | Deputy Director of Agriculture, Assam Valley. | Sugarcane station. |
| | Upper-Shillong | 367 | Ditto | Deputy Director of Agriculture, Surma Valley and Hills Districts. | Potato station |
| | Karimganj | 80 | Ditto | | Rice station. |
| | Shillong | 63 | Superintendent | ..... | |
| North-West Frontier Province. | Tarnab (Peshawar) | 200 | Manager | Agricultural Officer, North-West Frontier Province, Peshawar. | |
| | Haripur | 20 | Ditto | | |

## APPENDIX III.

*List of Agricultural Colleges and Schools in British India during 1920-21.*

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | | | *(a) Post-graduate Training Institution.* | |
| ... | Agricultural College, Pusa | Pusa, Bihar . . | 11 | Besides regular courses in Botany, Mycology, Agricultural Chemistry, Agricultural Bacteriology, Entomology, and General Agriculture, short courses in Sericulture and Lac-culture are also given. | |
| | | | | *(b) Provincial Agricultural Colleges.* | |
| Bombay . . | Poona Agricultural College | Poona . . | 203 | Affiliated to the University of Bombay who confer the Degree of B.Ag. on passed students. The course is for 3 years. Students before admission must have passed the Previous Examination of the Bombay University or Intermediate Examination in Arts, or in Science of any other Indian University or of the London University.<br><br>A short course in agriculture is also given to farmers' sons | |

*List of Agricultural Colleges and Schools in British India during 1920-21*—contd.

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of Instruction | Remarks |
|---|---|---|---|---|---|
| | | | | (*b*) *Provincial Agricultural Colleges*—concld. | |
| | | | | who know English but who are not qualified to take the University course in agriculture. This course lasts for 1 year. | |
| Madras . . | Agricultural College, Coimbatore. | Coimbatore . . | 102 | Three courses of instruction are given :—<br>(1) The first course (2 years) for Certificate of Proficiency in practical agriculture.<br>(2) The second course (18 months in continuation of the 1st course) for the Diploma or Licentiate in Agriculture<br>(3) New Diploma course (3 years)—this is eventually to replace No. 2 above. | |
| Central Provinces | Agricultural [College, Nagpur. | Nagpur . | 47 | The courses of instruction given are :—<br>(1) Four years' course for the Licentiate of Agriculture, and<br>(2) Two years' Diploma course for the sons of malguzars and substantial cultivators who intend to manage their own lands, and to | |

| | | | | |
|---|---|---|---|---|
| | | | | whom a full scientific course is unnecessary. |
| Bihar and Orissa | Agricultural College, Sabour. | Sabour (near Bhagalpur) | 57 | The course of instruction given is one of two years Certificate. Besides this, short season courses (*Bhadoi* and *Rabi*) are given. |
| United Provinces | Agricultural College, Cawnpore. | Cawnpore | 86 | Two courses of instruction are given :—<br>(1) Diploma (L.Ag.) course of 4 years, and<br>(2) Two years' or Vernacular course. |
| Punjab | Punjab Agricultural College. | Lyallpur | 199 | Affiliated to the Punjab University. Two courses of instruction are given :—<br>(1) Two years' course for Leaving Certificate ; and<br>(2) Four years' course for the Degree of B.Sc. in Agriculture. Besides, there are : a Vernacular Class which lasts for 1 year only, a Teachers' class which lasts for one year and a Rural Economy class which lasts for a shorter period. |
| | | *(c) Agricultural High and Middle Schools.* | | |
| Central Provinces. | Agricultural Middle School, Powarkhera. | Powarkhera Experimental Farm, District Hoshangabad. | 19 | 2 years' course. |
| | Agricultural Middle School, Chandkhuri. | Chandkhuri Experimental Farm, District Raipur. | 33 | 2 years' course |

*List of Agricultural Colleges and Schools in British India during 1920-21*—concld.

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | (c) *Agricultural High and Middle Schools*—concld. | | | |
| Bengal | Amarpur Middle English School. | Amarpur, District Burdwan. | 35 | Standard V and VI students are taught agriculture, both theoretical and practical, for six days in the week for one hour daily. | Both of these schools are mainly financed by local effort. |
| | Durgapur High English School. | Durgapur, District Chittagong. | ... | Students of classes VII and VIII are given training in agriculture, both theoretical and practical. | |
| | | (d) *Vernacular Agricultural Schools.* | | | |
| Bombay | Vernacular Agricultural School, Loni (in Marathi). | Loni, District Poona | 52 | 2 years' course. | |
| | Vernacular Agricultural School, Devi-hosur (in Kanarese). | Devi-hosur, District Dharwar. | 25 | 2 years' course. | |
| | Vernacular Agricultural School, Veshvi, Kolaba (in Marathi). | Veshvi, District Kolaba. | 12 | 2 years' course. | |
| | Vernacular Agricultural School, Jambul (in Marathi). | Jambul, District Thana. | 19 | 2 years' course. | |
| | Vernacular Agricultural School, Godhra (in Gujarati). | Godhra, District Panch-mahals. | 18 | 2 years' course. | |

| | | | | | |
|---|---|---|---|---|---|
| Bengal | Vernacular Agricultural School, Mirpurkhas (in Sindhi). | Mirpurkhas, District Thar and Parkar, Sind. | 12 | 1 year's course. | |
| | Vernacular Agricultural School, Dacca. | Dacca Central Farm | 30 | Curriculum is exactly the same as for class V of Middle Vernacular School with addition of field work. | A stipend of Rs. 10 per mensem is allowed for each pupil to meet feeding expenses. |
| | Vernacular Agricultural School, Chinsurah. | Chinsurah Agriculture Farm, District Hooghly. | 12 | Ditto | |
| Bihar and Orissa | Vernacular Agricultural School on Lower Primary basis attached to the C. M. S. Mission Upper Primary School. | Pathra (Godda), District Santal Parganas. | 50 | Practical training is given in cotton growing, rice cultivation, maize cultivation and gardening. | Receives a monthly grant of Rs. 30. |

## APPENDIX IV.

### *Operations of Non-Credit Agricultural Co-operative Societies in British India during 1920-21.*

The two tables below include Agricultural Societies for—

A. 1. *Purchase, and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghee*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

*Operations of Non-Credit Agricultural Co-operative Societies in British India during 1920-21*—contd.

(A) *Purchase, Sale and Production.*

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bombay | Purchase and Purchase and Sale. | 67 | 2,977 | 90,439 | 18,964 | 99,120 | +4,980 | |
| | Production | 20 | 535 | 150 | ... | 3,518 | +595 | |
| | Production and Sale | 31 | 4,234 | 1,00,167 | 1,10,942 | 1,32,203 | +8,240 | |
| | TOTAL | 118 | 7,746 | 1,90,756 | 1,29,906 | 2,34,841 | +13,815 | |
| Madras | Purchase and Purchase and Sale. | 63 | 4,676 | 1,74,313 | 43,781 | 3,12,718 | —761 | |
| | Production and Sale | 2 | 23 | ... | ... | 709 | —786 | |
| | Others | 2 | 158 | ... | ... | 725 | +112 | |
| | TOTAL | 67 | 4,857 | 1,74,313 | 43,781 | 3,14,152 | —1,435 | |
| Bengal | Purchase and Purchase and Sale. | 11 | 3,640 | 1,49,037 | 341 | 1,34,943 | +7,758 | |
| | Production | 7 | 665 | ... | ... | 10,836 | —632 | |
| | Production and Sale | 44 | 5,241 | 9,19,611 | 8,51,966 | 4,18,343 | +1,57,048 | |
| | TOTAL | 62 | 9,546 | 10,68,648 | 8,52,307 | 5,64,122 | +1,64,174 | |

*Operations of Non-Credit Agricultural Co-operative Societies in British India during 1920-21*—concld.

(A) *Purchase, Sale and Production*—concld.

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bihar and Orissa | Purchase and Purchase and Sale. | 1 | 20 | ... | ... | 548 | —29 | |
| | Production and Sale . . | 36 | 312 | 8,615 | 19,488 | 21,192 | +392 | |
| | TOTAL . | 37 | 332 | 8,615 | 19,488 | 21,740 | +363 | |
| United Provinces | Purchase and Purchase and Sale. | 1 | 73 | 2,968 | ... | 6,893 | —113 | |
| | Production . . . | 1 | 43 | ... | ... | 1,337 | +26 | |
| | Production and Sale . . | 8 | 322 | 24 | 12,865 | 28,720 | +217 | |
| | TOTAL . | 10 | 438 | 2,992 | 12,865 | 36,950 | +130 | |
| Punjab | Purchase and Purchase and Sale. | 171 | 1,537+1,845* | 3,53,657 | 1,08,208 | 3,35,051 | +4,993 | * Societies. |
| | Production and Sale . . | 19 | 597 | 3,46,395 | 11,545 | 1,61,355 | +15,845 | |
| | Others . . . . | 219 | 13,550 | ... | ... | 2,044 | +1,269 | |
| | TOTAL . | 409 | 15,684+1,845* | 7,00,052 | 1,19,753 | 4,98,450 | +22,107 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Burma | Purchase and Purchase and Sale. | 17 | 1,363 | 38,601 | ... | 16,424 | +149 |
| | Production | 2 | 130 | ... | ... | ... | ... |
| | Production and Sale | 52 | 5,150 | 2,79,822 | 2,18,831 | 3,55,455 | +7,427 |
| | Others | 36 | 588 | ... | ... | ... | ... |
| | TOTAL | 107 | 7,231 | 3,18,423 | 2,18,831 | 3,71,879 | +7,576 |

*Note.*—Figures for the Central Provinces and Berar were not received in time for inclusion in the table.

## (B) *Cattle Insurance.*

| PROVINCE | Number of societies | Amount of risk insured | Premia collected during the year | Supplementary contribution collected | NUMBER OF ANIMALS | | Claims paid | Cost of management | Funds in hand at end of year | Amount of risk re-insured | Amount of premia paid for re-insurance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Insured | Lost | | | | | |
| | | Rs. | Rs. | Rs. | | | Rs. | Rs. | Rs. | Rs. | Rs. |
| Bombay | 5 | 2,340 | 117 | ... | 85 | 4 | 80 | 61 | 495 | ... | ... |
| Punjab | 37 | 60,342 | 2,762 | 156 | 539 | 12 | 467 | 70 | 4,250 | 6,800 | 390 |
| | 1* | 6,060 | 371 | ... | 137 | 9 | 187 | ... | 792 | ... | ... |
| Burma | 381 | 1,43,972 | 5,023 | ... | 3,488 | 143 | 4,626 | 438 | 26,210 | 94,172 | 2,275 |
| | 1* | 94,172 | 2,485 | ... | 3,488 | 143 | 1,612 | 1,595 | 14,913 | ... | ... |

* Central Re-insurance Society.

## APPENDIX V.

*Table showing the working of the Provincial Civil Veterinary Departments during 1920-21.*

| Province | No. of Superior staff | | Research | Dispensaries and Hospitals | | | District staff and work | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Imperial Service Officers | Provincial Service Officers | | No. of Hospitals and Dispensaries | No. of Veterinary Assistants employed | No. of cases treated and castrations performed | No. of Inspectors | No. of Veterinary Assistants | No. of outbreaks in which inoculation was undertaken | Cases treated and castrations performed | Deaths uninoculated | Inoculations | Deaths after inoculation |
| Bombay | 3 | 6 | Rinderpest, examination of specimens, etc. | 73 | 73 | 1,36,507 | 5 | 73 | 468 | 44,413 | 5,879 | 63,714 | 416 |
| Madras | 4 | 6 | Examination of specimens, etc. | 58 | 58 | 71,261 | 15 | 51 | 561 | 40,877 | 9,988 | 66,086 | 296 |
| Bengal | 5 | 8 | Do. do. | 37 | 38 | 45,086 | 6 | 33 | 637 | 69,584 | 7,571 | 89,158 | 962 |
| Bihar and Orissa | 2 | 1 | Do. do. | 23 | 23 | 33,550 | 10 | 31 | 800 | 46,980 | 6,965 | 92,030 | 275 |
| United Provinces | 3 | 5 | Cattle tuberculosis, examination of specimens, etc. | 109 | 109 | 1,40,224 | 20 | 139 | 525 | 54,468 | 8,712 | 56,985 | 68 |
| Punjab | 11 | 7 | Examination of specimens, etc. | 145 | 146 | 3,91,997 | 19 | 163 | 863 | 80,988 | 7,389 | 1,87,942 | 154 |
| Burma | 4 | 9 | Do. do. | 4 | 1 | 2,241 | 25 | 295 | 659 | 37,912 | 6,857 | 60,785 | 377 |
| Central Provinces | 2 | 3 | Bovine trypanosomiasis, cattle tuberculosis, distomiasis, examination of specimens, etc. | 83 | 83 | 1,85,882 | 16 | 98 | 1,425 | 1,00,167 | 16,403 | 1,33,514 | 532 |
| Assam | 1 | 1 | Examination of specimens, etc. | 3 | 3 | 4,926 | 3 | 43 | 561 | 61,710 | 9,971 | 48,891 | 413 |
| North-West Frontier Province | ... | ... | Do. do. | 19 | 19 | 53,255 | 5 | 49 | 54 | 11,697 | 739 | 11,749 | 18 |
| Sind | 1 | 1 | Do. do. | 15 | 15 | 22,538 | ... | 15 | 207 | 5,680 | 4,650 | 20,735 | 263 |
| Baluchistan | 1 | ... | Do. do. | 6 | 6 | 8,666 | 1 | 6 | 106 | 2,456 | 1,966 | 13,399 | 25 |
| Rajputana | | | | 2 | 2 | 1,837 | ... | 2 | ... | 210 | ... | ... | ... |
| Total for 1920-21 | 36 | 47 | | 574 | 576 | 10,96,324 | 125 | 978 | 6,866 | 6,76,131 | 88,778 | 8,56,583 | 3,789 |
| Total for 1919-20 | 27 | 40 | | 537 | 536 | 11,84,497 | 124 | 965 | 5,551 | 8,47,942 | 70,963 | 7,00,795 | 2,476 |

## APPENDIX VI.

*Table showing the details as to Students of Veterinary Colleges and Schools in India during 1920-21.*

| Veterinary College or School | Course of instruction | Number of students | | | | | | Students admitted during the year, classed by educational qualifications | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Admitted during the year | | Passed final examination during the year | Failed to pass final examination | Remaining under instruction at end of the year | | Matriculates, school finals or with higher qualifications | Knowing some English but not matriculates | Knowing no English or very little English |
| | | Scholarship-holders | Others | | | In ordinary course | Instruction prolonged by reason of failure to pass | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Bombay Veterinary College | 3 years' English course. | 20 | 15 | 21 | 6 | 32 | 7 | 5 | 30 | ... |
| Madras „ „ | Do. | 39 | ... | 27 | 7 | 48 | 8 | 39 | ... | ... |
| Bengal „ „ | Do. | 40 | 23 | 24 | 21 | 84 | 43 | 34 | 29 | ... |
| Punjab „ „ | 3 year's Vernacular course. | 13 | 67 | 58 | 5 | 157 | 34 | 11 | 64 | 5 |
| Burma— | | | | | | | | | | |
| Insein School | 3 years' Vernacular course. | 17 | ... | 18 | ... | 41 | ... | ... | ... | 17 |
| Taunggyi School | 1½ Do. | 5 | ... | 5 | ... | 6 | 1 | ... | ... | 5 |

## APPENDIX VII.

*List of Agricultural Publications in India during 1920-21.*

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** | | |
| 1 | The *Agricultural Journal of India*, Vol. XV, Parts IV, V and VI, and Vol. XVI, Parts I, II and III. Price R. 1-8 or 2*s.* per part ; annual subscription Rs. 6 or 9*s.* 6*d.* | Edited by the Agricultural Adviser to the Government of India, Pusa. | Messrs. Thacker, Spink and Co., Calcutta. |
| 2 | Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Secretary, Sugar Bureau) for 1919-20. Price R. 1. | Issued from the Agricultural Research Institute, Pusa. | Government Printing India, Calcutta. |
| 3 | Review of Agricultural Operations in India, 1919-20. Price R. 1-4. | Agricultural Adviser to the Government of India, Pusa. | Ditto |
| 4 | The Conditions affecting the quality of the Java Indigo Plant (Leaf yield and richness of the leaf in indigotin). Pusa Indigo Publication No. 7 Price As. 9. | W. A. Davis, B.SC., A.C.G.I., Indigo Research Chemist. | Ditto |
| 5 | Note on the Development of the Indigo Industry in Assam in conjunction with Tea and other Crops. Pusa Indigo Publication No. 8. Price As. 3. | Ditto | Ditto |
| 6 | Note on the Deterioration of Indigo Seed during Storing. Pusa Indigo Publication No. 10 Price As. 3. | Major W. R. G. Atkins, SC.D., F.I.C., Indigo Botanist to the Government of India. | Ditto |
| 7 | A Summary of the Experiments on Rice in Bihar and Orissa from 1912 to 1919. Pusa Agricultural Research Institute Bulletin No. 96. Price As. 10. | G. C. Sherrard, B.A., Deputy Director of Agriculture, Patna Circle, Bihar and Orissa. | Ditto |
| 8 | The Preparation and Reproduction of Scientific Illustrations. Pusa Agricultural Research Institute Bulletin No. 114 Price As. 4. | A. W. Slater, Manager, Calcutta Phototype Company. | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 9 | The Saving of Irrigation Water in Wheat growing. Pusa Agricultural Research Institute Bulletin No. 118. Price As. 4. | A. Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist. | Government Printing India, Calcutta. |
| 10 | Annual Report of the Board of Scientific Advice for India for the year 1919-20. Price R. 1. | Issued by the Board of Scientific Advice for India. | Ditto |
| 11 | Prices and Wages in India (thirty-fifth issue). Price Rs. 2 or 3*s*. | Issued by the Department of Statistics, India. | Ditto |
| 12 | Estimates of Area and Yield of Principal Crops in India, 1919-20. Price As. 8. | Ditto | Ditto |
| 13 | Summary of Tables showing the total area, area cultivated and uncultivated, area under irrigation, and area under different crops, in British India in the agricultural year 1919-20. Price As. 4. | Ditto | Ditto |
| 14 | Report on the First Census of Live-stock, Ploughs and Carts in India, held between December 1919 and April 1920. Price As. 4. | Ditto | Ditto |
| 15 | Agricultural Statistics of Bengal for 1919-20. Price R. 1-12. | Government of Bengal, Revenue Department. | Bengal Secretariat Book Depôt, Calcutta. |
| 16 | Annual Report of the Department of Agriculture, Bengal, for the year 1919-20. Price Rs. 3-10. | Issued by the Department of Agriculture, Bengal. | Ditto |
| 17 | Season and Crop Report of Bengal for 1920-21. Price Rs. 2. | Ditto | Ditto |
| 18 | Cattle Census Report of the Presidency of Bengal. Price R. 1-2. | Ditto | Ditto |
| 19 | Proceedings of the 42nd Regular Meeting of the Bengal Silk Committee held in Calcutta on the 23rd August, 1920. | Ditto | Bengal Secretariat Press, Calcutta. |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 20 | Proceedings of a Departmental Agricultural Conference held at Dacca on the 6th and 7th December, 1920. | Issued by the Department of Agriculture, Bengal. | Bengal Secretariat Press, Calcutta. |
| 21 | A Short History of Cotton Experimental Cultivation in Bengal. Bengal Department of Agriculture Bulletin No. 1 of 1921. (In English and Bengali.) | G. Evans, M.A., C.I.E., Director of Agriculture, Bengal. | The Bengal Secretariat Book Depôt, Calcutta. |
| 22 | Historical Notes on Experiments with Jute in Bengal. Bengal Department of Agriculture Bulletin No. 2 of 1921. (In English and Bengali.) | R. S. Finlow, B.SC., F.I.C., Fibre Expert, Bengal. | Ditto |
| 23 | *Dhaincha*—A Manure for Aman Paddy. Bengal Department of Agriculture Leaflet No. 1. | Issued by the Department of Agriculture, Bengal. | Ditto |
| 24 | Advice to Jute Growers. Bengal Department of Agriculture Leaflet No. 3. (In English and Bengali.) | R. S. Finlow, B.SC., F.I.C., Fibre Expert, Bengal. | Ditto |
| 25 | Adulterated Manure, warning of Agricultural Chemist, Bengal. Bengal Department of Agriculture Leaflet No. 4. | Issued by the Department of Agriculture, Bengal. | Ditto |
| 26 | *Bengal Agricultural Journal* (Quarterly). Vol. I, Nos. 1 & 2. (In English and Bengali.) Annual subscription R. 1-4; single copy As. 5. | Ditto | Sreenath Press, Dacca. |
| 27 | Annual Report of the Department of Agriculture, Bihar and Orissa, for 1919-20. Price As. 6. | Issued by the Department of Agriculture, Bihar and Orissa. | Bihar and Orissa Government Press, Patna. |
| 28 | Season and Crop Report of Bihar and Orissa for 1920-21. Price R. 1-6. | Ditto | Ditto |
| 29 | Sugarcane areas in Bihar and Map of the Patna Division (with explanatory note). | Ditto | Messrs. Thacker, Spink & Co., Calcutta. |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 30 | Agricultural Statistics of Bihar and Orissa for 1919-20. Price R. 1-8. | Issued by the Department of Agriculture, Bihar and Orissa. | Bihar and Orissa Government Press, Patna. |
| 31 | Report on the Administration of the Agricultural Department of the United Provinces of Agra and Oudh for the year ending 30th June, 1920. Price As. 8. | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 32 | Season and Crop Report of the United Provinces of Agra and Oudh for 1919-20. Price As. 10. | Ditto | Ditto |
| 33 | Report on the Agricultural Stations of the Western Circle, United Provinces of Agra and Oudh, for the year ending 31st May, 1920. Price As. 6. | Ditto | Ditto |
| 34 | Report on the Agricultural Experiment Stations in the Central Circle, United Provinces, for the year ending 30th June, 1920. Price R. 1. | Ditto | Ditto |
| 35 | Report on the Agricultural Stations in the Eastern Circle, United Provinces, for the year ending 30th June, 1920. Price As. 7. | Ditto | Ditto |
| 36 | The United Provinces Cattle Census of 1920. Price As. 2. | Ditto | Ditto |
| 37 | Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1920, Part I. Price As. 10. or 10*d*. | Issued by the Department of Agriculture, Punjab. | Government Printing Punjab, Lahore. |
| 38 | Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1920, Part II. (Annual Experiment Record.) Price Rs. 4-8 or 6*s*. | Ditto | Ditto |
| 39 | Season and Crop Report of the Punjab for the year 1919-20. Price R. 1-6 or 2*s*. 6*d*. | Ditto | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 40 | Tables of the Agricultural Statistics of the Punjab for the year 1919-20. | Issued by the Department of Agriculture, Punjab | Government Printing Punjab, Lahore. |
| 41 | Annual Report of the Lawrence Gardens, Lahore, for 1919-20. Price As. 2. | Ditto | Ditto |
| 42 | Bulletin on Experiments at Agricultural Station, Lyallpur. Price As. 8. | O. T. Faulkner, B.A., Deputy Director of Agriculture, Punjab. | Ditto |
| 43 | Annual Report of the Department of Agriculture, Bombay Presidency, for 1919-20. | Issued by the Department of Agriculture, Bombay. | Yeravda Prison Press, Poona. |
| 44 | Season and Crop Report of the Bombay Presidency for 1919-20. | Ditto | Government Central Press, Bombay. |
| 45 | Proceedings of the Bombay Provincial Board of Agriculture held at Poona on the 9th and 10th June, 1920. Price As. 10. | Ditto | Ditto |
| 46 | Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1919-20. Price As. 4. | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 47 | Season and Crop Report of the Madras Presidency for 1919-20. Price As. 12. | Ditto | Ditto |
| 48 | Some aspects of Dairying at the Madras Agricultural College, Coimbatore. Madras Department of Agriculture Bulletin No. 79. | D. Ananda Rao Garu, B.Sc. | Ditto |
| 49 | Villager's Calendar, 1920-21 | Issued by the Department of Agriculture, Madras. | Ditto |
| 50 | Annual Report of Agricultural Stations of the Madras Presidency, 1919-20 (for official use only). | Ditto | Ditto |
| 51 | Note on Pepper Cultivation. Madras Department of Agriculture Leaflet No. 10. | Ditto | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 52 | Note on the Cultivation of Modan Paddy. Madras Department of Agriculture Leaflet No. 11. | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 53 | Note on Sugarcane Cultivation on the West Coast. Madras Department of Agriculture Leaflet No. 12. | Ditto | Ditto |
| 54 | Report on the working of the Department of Agriculture, Central Provinces and Berar, 1919-20. Price R. 1. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Central Provinces, Nagpur. |
| 55 | Season and Crop Report of the Central Provinces and Berar for 1919-20. Price R. 1. | Ditto | Ditto |
| 56 | Report on Agricultural Stations, Southern Circle, Central Provinces, for 1919-20. Price R. 1. | Ditto | Ditto |
| 57 | Report on Agricultural Stations, Northern Circle, Central Provinces, for 1919-20. Price As. 8. | Ditto | Ditto |
| 58 | Report on the Agricultural Stations in the Western Circle, Central Provinces, for 1919-20. Price As. 8. | Ditto | Ditto |
| 59 | Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1919-20. Price As. 8. | Ditto | Ditto |
| 60 | Report on Demonstration Work in the Southern Circle, Central Provinces, for 1919-20. Price As. 8. | Ditto | Ditto |
| 61 | Report on Demonstration Work in the Northern Circle, Central Provinces, for 1919-20. Price As. 8. | Ditto | Ditto |
| 62 | Report on Demonstration Work in the Western Circle, Central Provinces, for 1919-20. Price As. 8. | Ditto | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 63 | Report on the Agricultural College, Nagpur; Botanical and Chemical Research and Maharajbagh Menagerie, for 1919-20. Price As. 8. | Issued by the Department of Agriculture, Central Provinces. | Government Press, Central Provinces, Nagpur. |
| 64 | Unsuitability of certain well waters for irrigation purposes. Leaflet of the Central Provinces Department of Agriculture. | Ditto | Ditto |
| 65 | The Sindewahi improved Furnace for Gur Manufacture. Central Provinces Department of Agriculture Bulletin No. 8 of 1920. Price As. 2. | G. K. Kelkar, Extra Assistant Director of Agriculture, Bhandara. | Ditto |
| 66 | Report on the Operations of the Department of Agriculture, Burma, for 1919-20. Price As. 8. | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |
| 67 | Season and Crop Report of Burma for 1919-20. Price R. 1. | Ditto | Ditto |
| 68 | Annual Reports of the Agricultural Stations, the Agricultural Chemist, the Agricultural Engineer and the Economic Botanist, Burma, for 1919-20. | Ditto | Ditto |
| 69 | Tables of Agricultural Statistics of Upper Burma for 1919-20. | Ditto | Ditto |
| 70 | Cultivation and Preparation of Rubber in Burma. Burma Department of Agriculture Bulletin No. 7 (1911) (Revised and Rewritten). | Ditto | Ditto |
| 71 | Cambodia Cotton. Burma Department of Agriculture Cultivators' Leaflet No. 56. | Ditto | Ditto |
| 72 | Minutes of the Meeting of Provincial Cotton Committee held at Myingyan on the 15th November, 1920 (in Burmese). | Ditto | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 73 | Minutes of the Meeting of the Provincial Cotton Committee held at Myingyan on the 15th July, 1921 (in Burmese). | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |
| 74 | Onion Cultivation. Burma Cultivators' Leaflet No. 57. | Ditto | Ditto |
| 75 | Annual Report of the Department of Agriculture, Assam, for 1919-20. Price As. 8 or 1*s*. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 76 | Season and Crop Report of Assam for the year 1920-21. Price As. 8 or 1s. | Ditto | Ditto |
| 77 | Report of the Agricultural Experiments and Demonstrations in Assam for the year ending 31st March, 1920. | Ditto | Ditto |
| 78 | Tables of Agricultural Statistics of Assam for the year 1919-20. | Ditto | Ditto |
| 79 | Report on Tea Culture in Assam for the year 1920. Price As. 8 or 1*s*. | Ditto | Ditto |
| 80 | Report on the Season and Crops of the North-West Frontier Province for 1919-20. Price R. 1-4. | Issued by the Department of Agriculture, North-West Frontier Province. | Government Press, Peshawar. |
| 81 | Summary of Remarks on the Kharif Crop of the North-West Frontier Province for 1920. Price As. 12. | Revenue Commissioner, North-West Frontier Province. | Ditto |
| 82 | Report on the Operations of the Department of Agriculture and Fisheries, Travancore, for 1919-20. | Issued by the Department of Agriculture and Fisheries, Travancore. | Government Press, Trivandrum. |
| 83 | Report of the Administration of Fisheries, Avenues, Public Gardens and of the Agricultural Department in the Cochin State for 1919-20. | Issued by the Department of Agriculture, Cochin. | Cochin Government Press, Ernaculam. |
| 84 | *Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy. | Issued by the Scientific Department of the Indian Tea Association. | Catholic Orphan Press, Calcutta. |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*concld.* | | |
| 85 | The *Journal of the Madras Agricultural Students' Union* (Monthly). Annual Subscription Rs. 2. | Madras Agricultural Students' Union, Coimbatore. | Literary Sun Press, Coimbatore. |
| 86 | *Indian Scientific Agriculturist.* Annual subscription Rs. 4. | Alliance Advertising Association, Ltd., Calcutta | Messrs. Bera & Co. Printers, Calcutta. |
| 87 | *Poona Agricultural College Magazine* (Quarterly). Annual subscription Rs. 2. | College Magazine Committee, Poona. | Arya Bhusan Press, Poona. |
| 88 | The *Planters' Chronicle* (Weekly) | United Planters' Association of South India, Coimbatore. | Daily Post Press, Bangalore. |
| 89 | *Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription Rs. 3. | Mysore Agricultural Experimental Union. | Bangalore Press, Bangalore. |
| | **AGRICULTURAL CHEMISTRY.** | | |
| 90 | The Gases of Swamp Rice Soils. Part V. A Methane-oxidizing Bacterium from Rice Soils.<br>Part VI. Carbon Dioxide and Hydrogen in relation to Rice Soils.<br>Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, Nos. 7 & 8. Price As. 12 or 1*s.* 3*d.* | P. A. Subramania, B.A., Assistant to the Government Agricultural Chemist, Madras.<br>W. H. Harrison, D.SC., Imperial Agricultural Chemist. | Messrs. Thacker, Spink & Co., Calcutta. |
| 91 | The Retention of Soluble Phosphates in Calcareous and Non-calcareous Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, No. 9. Price R. 1 or 1*s.* 4*d.* | W. H. Harrison, D.SC., Imperial Agricultural Chemist, and Surendralal Das, M.SC., Assistant to the Imperial Agricultural Chemist. | Ditto |
| 92 | Windrowing Sugarcane in the North-West Frontier Province.<br>Part I. The Effect on the Economical and Agricultural Situation.<br>Part II. The Effect on the Composition of Sugarcane.<br>Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, No. 10. Price As. 12 or 1*s.* | W. Robertson Brown, Agricultural Officer, North-West Frontier Province.<br>W. H. Harrison, D.SC., Imperial Agricultural Chemist, and P. B. Sanyal, M.SC., Assistant to the Imperial Agricultural Chemist. | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **AGRICULTURAL CHEMISTRY** —*concld.* | | |
| 93 | Studies in Soil Moisture, Part I. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 3. Price R. 1-8 or 2*s*. | B. H. Wilsdon, B.A. (Oxon.), I.E.S., Agricultural Chemist, Punjab. | Messrs. Thacker, Spink & Co., Calcutta. |
| 94 | A Survey of the Indian Poppy-growing Districts for Morphine Content of the Opium produced. Pusa Agricultural Research Institute Bulletin No. 116. Price As. 2. | H. E. Annett, D.SC., F.I.C., M.S.E.A.C., Agricultural Chemist, Bengal (on special duty, Cawnpore), and Hari Das Sen, M.SC., Har Dayal Singh, B.SC., Assistants to above. | Government Printing, India, Calcutta. |
| 95 | The Nature of the Changes occurring during the Extraction of Indigo from the Java Plant (*Indigofera arrecta.*) Pusa Indigo Publication No. 9. Price R. 1. | W. A. Davis, B.SC., A.C.G.I., Indigo Research Chemist to the Government of India. | Ditto |
| 96 | Proceedings of the Second Meeting of Agricultural Chemists and Bacteriologists held at Pusa on the 7th February, 1921, and following days. Price As. 10. | Issued from the Agricultural Research Institute, Pusa. | Ditto |
| | **BOTANY.** | | |
| 97 | "Kumpta" Cotton and its Improvement. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. X, No. 6. Price R. 1-12 or 3*s*. | G. L. Kottur, B.AG., Cotton Supervisor, Southern Division, Bombay Presidency. | Messrs. Thacker, Spink & Co., Calcutta. |
| 98 | Some Aspects of the Indigo Industry in Bihar Part I. The Wilt Disease of Indigo in Bihar. Part II. The Factors underlying the Seed production and growth of Java Indigo. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 1. Price R. 1-2 or 2*s*. | Albert Howard C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L.C. Howard, M.A., Second Imperial Economic Botanist (with the assistance of Chowdhury Ram Dhan Singh and Moulvi Abdur Rahman Khan, Assistants to the Imperial Economic Botanist). | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
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| | **MYCOLOGY.** | | |
| 99 | Studies in Diseases of the Jute Plant. (1) *Diplodia Corchori* Syd. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 2. Price Rs. 2 or 2*s*. 8*d*. | F. J. F. Shaw, D.SC. (Lond.), A.R.C.S., F.L.S., Second Imperial Mycologist. | Messrs. Thacker, Spink & Co., Calcutta. |
| 100 | Morphology and Parasitism of *Acrothecium Penniseti* n. sp. (A new disease of *Pennisetum typhoideum*). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 3. Price R. 1-4 or 2*s*. | Manoranjan Mitra, M.SC., First Assistant to the Imperial Mycologist. | Ditto |
| 101 | Proceedings of the Third Meeting of Mycological Workers in India held at Pusa on the 7th February, 1921, and following days. Price As. 11. | Issued from the Agricultural Research Institute, Pusa. | Government Printing India, Calcutta. |
| 102 | *Ustilago Crameri* Koern. on *Setaria italica* Beauv. Pusa Agricultural Research Institute Bulletin No. 97. Price As. 4. | S. Sundararaman, M.A., Acting Government Mycologist, Madras. | Ditto |
| 103 | A Brief description of some of the fungoid diseases of crops in Central Provinces and Berar. Central Provinces and Berar Department of Agriculture Bulletin No. 9 of 1921. Price As. 8. | K. P. Shrivastava, Offg. Economic Botanist, Central Provinces. | Government Press, Nagpur. |
| 104 | Potato Disease. Assam Department of Agriculture Leaflet No. 3 of 1920 (in Khasi). | Issued by the Department of Agriculture, Assam. | The Assam Secretariat Printing Office, Shillong. |
| 105 | Result of Investigations made by the Department of Agriculture, Burma, into the extent of the damage caused by a Parasite plant known in Burmese as "Pwinbyu." | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY.** | | |
| 106 | Life-Histories of Indian Insects: Microlepidoptera. Memoirs of the Imperial Department of Agriculture in India, Entomological Series, Vol. VI, Nos. 1-9. Price Rs. 7-8 or 11*s.* 3*d.* | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist. | Messrs. Thacker, Spink & Co., Calcutta. |
| 107 | Indian Grass Gall Midges. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 3. Price As. 10 or 1*s.* | E. P. Felt, State Entomologist of New York, U. S. A. | Ditto |
| 108 | New Indian Gall Midges (*Itonididæ*). | Ditto | Ditto |
| | Three New Wasps from India. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, Nos. 4 and 5. Price As. 12 or 1*s.* | G. R. Dutt, B.A., Personal Assistant to the Imperial Entomologist. | |
| 109 | Report of the Proceedings of the 3rd Entomological Meeting held at Pusa, 3rd to 15th February, 1919. Price per complete set of 3 vols. Rs. 17-8. | Edited by T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist. | Government Printing, India, Calcutta. |
| 110 | Instructions for Rearing Mulberry Silkworms. Pusa Agricultural Research Institute Bulletin No. 39. Third (Revised) Edition. Price R. 1-3. | M. N. De, Sericultural Assistant, Pusa. | Ditto |
| 111 | Cotton Bollworms in India. Pusa Agricultural Research Institute Bulletin No. 105. Price As. 8. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, and C. S. Misra, B.A., First Assistant to the Imperial Entomologist. | Ditto |
| 112 | Experiments in Egypt on the survival of the Pink Bollworms (resting stage larvæ) in ripe damaged Cotton Bolls buried at different depths. Pusa Agricultural Research Institute Bulletin No. 107. Price As. 5. | F. C. Willcocks, Entomologist to the Sultanic Agricultural Society, Cairo, Egypt. | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY**—*concld.* | | |
| 113 | The Preservation of Wood against Termites. Pusa Agricultural Research Institute Bulletin No. 110. Price As. 3. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist. | Government Printing, India, Calcutta. |
| | **BACTERIOLOGY.** | | |
| 114 | Pebrine in India. Memoirs of the Imperial Department of Agriculture in India, Bacteriological Series, Vol. I, No. 8. Price Rs. 3-8 or 5*s.* 6*d.* | C. M. Hutchinson, C.I.E., B.A., Imperial Agricultural Bacteriologist. | Messrs. Thacker, Spink & Co., Calcutta. |
| | **VETERINARY.** | | |
| 115 | Annual Report of the Imperial Bacteriological Laboratory, Muktesar, for the year ending 31st March, 1920. Price As. 5. | Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Government Printing, India, Calcutta. |
| 116 | Virulence of Tubercle Bacilli isolated from Bovine Lesions in India. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. III, No.2. Price R. 1-4 or 1s. 8*d.* | A. L. Sheather, B.SC., M.R.C.V.S., Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Messrs. Thacker, pink & Co., Calcutta. |
| 117 | Bovine Lymphangitis. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. III, No. 3. Price R. 1-8 or 2*s.* | Ditto | Ditto |
| 118 | A note on treatment of Surra in Camels by intravenous injections of Tartar Emetic. Pusa Agricultural Research Institute Bulletin No. 95. Price As. 2. | H. E. Cross, M.R.C.V.S., D.V.H., A.SC., Camel Specialist, Sohawa, Punjab. | Government Printing, India, Calcutta. |
| 119 | The Course that Surra runs in Camels when naturally contracted and when artificially inoculated. Pusa Agricultural Research Institute Bulletin No. 98. Price As. 5. | Ditto | Ditto |

*List of Agricultural Publications in India during 1920-21*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*contd.* | | |
| 120 | The Course that Camel Surra runs in Ponies, Buffaloes and other Animals. Pusa Agricultural Research Institute Bulletin No. 99. Price As. 4. | H. E. Cross, M.R.C.V.S., D.V.H., A.SC., Camel Specialist, Sohawa, Punjab. | Government Printing, India, Calcutta. |
| 121 | Annual Report of the Civil Veterinary Department, Bengal, for 1919-20. | Issued by the Civil Veterinary Department, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 122 | Annual Report of the Bengal Veterinary College for 1919-20. | Ditto | Ditto |
| 123 | Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1919-20 Price As. 12. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Press, Bihar and Orissa, Patna. |
| 124 | Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1920. Price As. 11. | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 125 | Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for the year 1919-20. Price As. 8 or 11*d.* | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 126 | Annual Report of the Camel Specialist for 1919-20. Price As. 3. | Ditto | Ditto |
| 127 | Wire Worm. Punjab Veterinary Bulletin No. 1 of 1920 (Gratis). | Ditto | Ditto |
| 128 | List of Horse and Cattle Fairs and Shows in the Punjab and Native States during 1919-20. | Ditto | Ditto |
| 129 | Poisoning in Cattle from eating Jowar (*Andropogon Sorghum*). Punjab Veterinary Bulletin No. 1 of 1921. | Lt.-Col. G. K. Walker, C.I.E., O.B.E., Principal, Punjab Veterinary College. | Ditto |
| 130 | Report of the Bombay Veterinary College and Civil Veterinary Department, Bombay Presidency including Sind, for 1919-20. Price As. 6. | Issued by the Department of Agriculture, Bombay. | Government Central Press, Bombay. |

*List of Agricultural Publications in India during 1920-21*—concld.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*concld.* | | |
| 131 | Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1919-20. | Issued by the Civil Veterinary Department, Madras. | Government Press, Madras. |
| 132 | Hæmorrhagic Septicæmia. Madras Veterinary Department Leaflet No. 5 of 1921. | Ditto | Ditto |
| 133 | Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1919-20. Price R. 1. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Central Provinces, Nagpur. |
| 134 | Report of the Civil Veterinary Department (including the Insein Veterinary School), Burma, for the year ending 31st March, 1920. Price R. 1. | Issued by the Civil Veterinary Department, Burma. | Government Printing, Burma, Rangoon. |
| 135 | Report of the Civil Veterinary Department, Assam, for 1919-20. Price As. 8 or 1*s*. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 136 | Report of the Civil Veterinary Department, North-West Frontier Province, for 1919-20. Price R. 1. | Issued by the Civil Veterinary Department, North-West Frontier Province. | Government Press, Peshawar. |

CALCUTTA : PRINTED BY SUPDT. GOVT. PRINTING, INDIA, 8, HASTINGS STREET.

# Review of Agricultural Operations in India 1921-22

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1923

# PREFACE

The Agricultural Department in India as at present constituted dates from the year 1905 when a complete reorganization of the existing department was determined upon by the Government of India. A period of reconstruction followed, during which it was found necessary to make an entirely fresh start, and for years the new department grappled with the almost overwhelming problems which faced it.

Most valuable plants are tender when young and it would not have been difficult to have stifled the Agricultural Department in its infancy or to have guided it into unprofitable channels. This publication, containing as it does a record of results achieved, will, it is hoped, provide sufficient justification of the early policy in attacking large problems, instead of, as might easily have been done, engaging in abstruse though no doubt interesting investigations with little or no immediate practical application.

One by one the major crops of the country—rice, wheat, cotton, jute, sugarcane—have been taken up and each has yielded results which can and are being applied to large areas. What has been done is, however, only a beginning, but the general success in approaching crop problems from the varietal point of view has undoubtedly acted as a valuable stimulus towards attacking the admittedly more difficult problem of the general improvement of cultural methods. That this problem will yield to treatment no one in the Agricultural Department has now any doubts. The more immediate future lies with the irrigated tracts, but possibilities are opening out for the improvement of moisture conditions in the drier rain-fed areas by a better and earlier cultivation of the soil by means of better farm implements, while for the rice areas there is undoubtedly a great future in manuring, should the price of food grains remain high. Progress will to no small extent depend on the success of the Co-operative Movement, but the discovery of objects for the attainment of which Co-operation is necessary

or advantageous should in turn strengthen the movement itself: in other words, the possibility of agricultural improvement should prove the best stimulus to Co-operation in rural areas.

This review, being in the nature of an annual progress report, deals with much that has received mention in previous years. Prominent amongst the new features of this year's operations are the work of the Indian Central Cotton Committee which proposes to find its own funds for research by a small cess levied on cotton bales, and the successful trials on a field scale of the seedling sugarcanes bred at the All-India Sugarcane Station at Coimbatore in Madras—a successful outcome of the distinguished work, performed under great difficulties in the closing years of his service, by Dr. C. A. Barber, late Imperial Sugarcane Expert, ably assisted by his staff.

PUSA,
*January 12th, 1923.*

S. MILLIGAN,
*Agricultural Adviser to the Government of India.*

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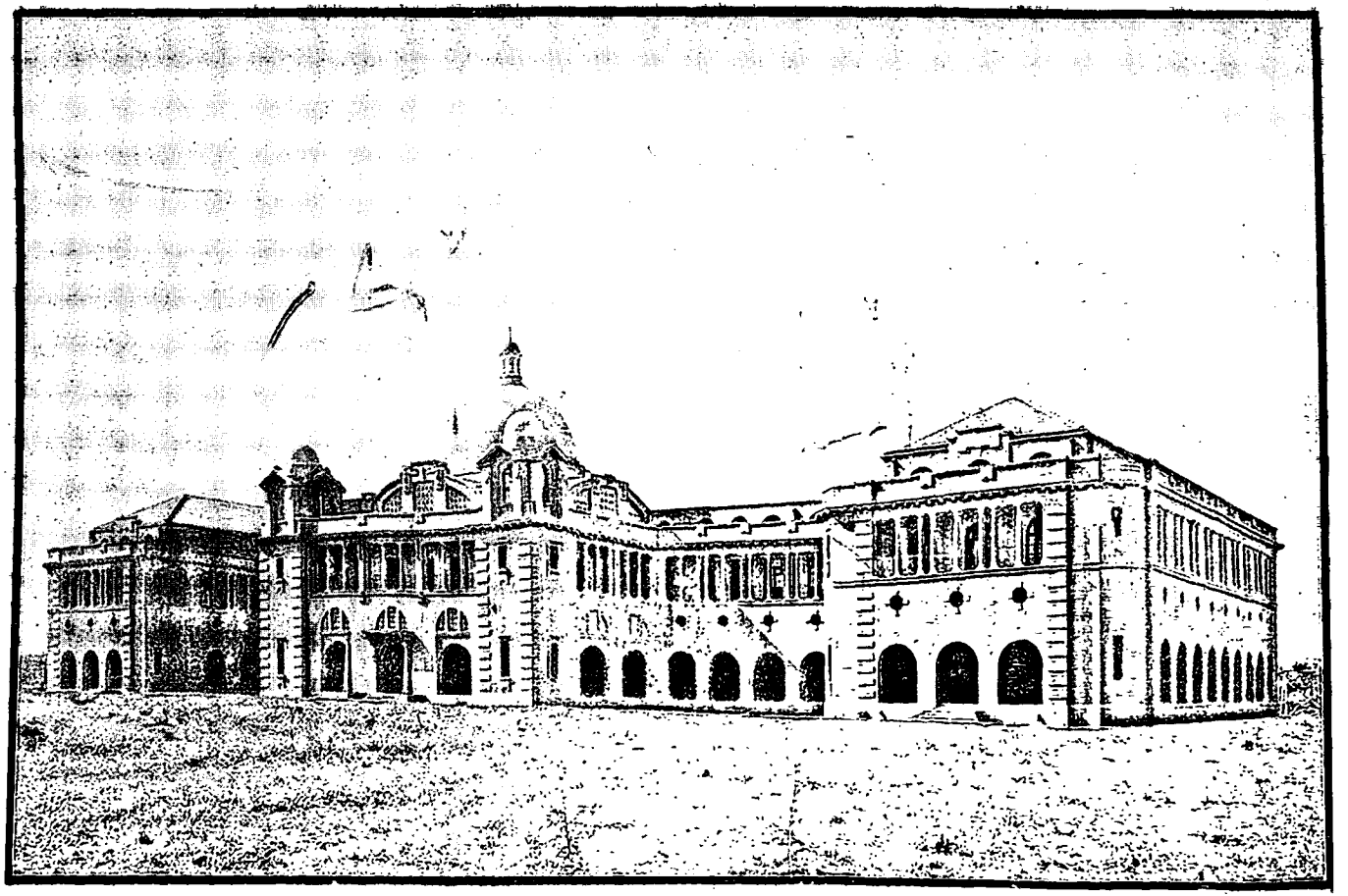


THE POONA AGRICULTURAL COLLEGE.

# Review of Agricultural Operations in India 1921-22

## CHAPTER I.

### AGRICULTURAL CONDITIONS OF THE YEAR.

The monsoon of 1921 made a comparatively late start (not always a disadvantage) and gave roughly normal rainfall in all provinces. Winter depressions began rather early and unusually heavy rain fell in North-West India (excluding Rajputana and Gujarat) in the period October to December. An ideal combination of climatic conditions over a vast country with varying physical features occurs only at rare intervals, but, taking India as a whole, the season 1921-22, in marked contrast to that of the previous year, may be classed as a favourable one from the agricultural point of view, almost all the important crops giving good yields with an average outturn per acre much above that of the last ten years. The exceptions were jute and tea which suffered from the unequal distribution of rainfall which characterized the season in Bengal and Assam.

The material condition of the agricultural population, depending as it does primarily on good seasons, was thus generally good. The continued high prices for agricultural produce helped the agriculturist to meet the rising cost of living, while the ample demand for labour insured good wages for the hired man.

The year was also a better one for live stock. The supply of fodder was better, epidemics were less severe, and the ascertained mortality was lower than in the preceding year.

## CHAPTER II.

## ECONOMIC WORK ON CROPS.

As stated in previous reports, the principal economic work on crops consists in the provision of improved varieties of existing crops, that is to say, varieties which by their general efficiency and suitability to local conditions are more profitable than those in ordinary use. The measure of success achieved in this line is indicated in Appendix I to this review, but it must be accepted as only a beginning and is nothing to what can and will be done in future when the efforts of plant-breeding in combating disease and avoiding natural disadvantages, such as short seasons, drought, etc., bear full fruit. The time has, however, come when more attention must be paid to the other factors in crop production, *viz.*, cultural methods and the maintenance of the fertility of the soil. The varietal work on crops has already prepared the way for improvements in cultivation and manuring. It has given the ryot an incentive to better methods of treating his land by showing him that there are varieties of crops which will repay more detailed attention. Careful investigation in each representative tract by competent workers filled with a zeal for accurate scientific investigation is therefore imperative, and it should always be borne in mind that thorough fundamental work will always produce sounder and more lasting results.

### I. Rice.

Rice is the premier crop of India both as regards area and the value of its outturn. Moreover, unlike others, it is the only known crop which could be grown without an elaborate system of drainage over millions of acres. On an average it occupies nearly 35 per cent. of the total cultivated area of India, and is the staple food of the Eastern Provinces, Burma and Southern India. In 1921-22, the total returned area under this crop showed a decline from 81,968,000* in the previous year to 81,256,000 acres, but, thanks to the well distributed rainfall, the estimated yield rose from 27,703,000* to

* Revised figures.

33,038,000 tons, an increase of no less than 5,335,000 tons or 19 per cent., with an outturn per acre of 125 lb. and 32 lb. above the previous year and the last decennial average, respectively.

In BENGAL, paddy occupies over 21 million acres or 71 per cent. of the cropped area of the province and 26 per cent. of the total acreage under this crop in India. The efforts of the Agricultural Department in this province have thus been largely directed to the improvement of the rice crop. Much progress has already been achieved towards providing higher yielding varieties, but search for better varieties has shown the possibilities of further improvement. In addition to Indrasail, which continues to spread steadily in Eastern and Northern Bengal, three *aman* varieties, *viz.*, Dhepi, Dudsar and Tilakkacheri, have been isolated. These are all heavy yielders and can be recommended for distribution in suitable localities. Dudsar, when tested on a large scale on the Chinsura farm, beat the local Nagra by 14 per cent., and, being also earlier in ripening than Indrasail, should prove very suitable for Western Bengal. Intra-varietal selection on two selected varieties of *aus* paddy, *viz.*, Kataktara and Surajmukhi, carried on for seven years, has given remarkable result of the isolation of types which yield 34–41 per cent. more than the original pure line of Kataktara. Work on deep-water paddies has also been started and a few strains have been selected for their heavy yield, but, owing to the complexity of the deep-water paddy problem which is, to no small degree, one of flood resistance, collection of considerable data for a number of years is necessary. An endeavour is being made by cross-breeding to obtain types suitable for land intermediate between ordinary highland *aus* and transplanted *aman* paddy land. One fact of great value has already emerged, *viz.*, a strong correlation between colour and earliness of *aus*, and absence of colour and lateness of *aman* paddy. Further work on transpiration of rice has proved it to be a varietal character.

Definite results achieved during several successive years at Chinsura have established the superiority of *dhaincha* (*Sesbania*) green-manuring for *aman* paddy. Experiments

will next be conducted to find out whether the addition of phosphate will further increase its value, as it has done in parts of Bihar.

In MADRAS, as in Bengal, rice is the main crop dealt with by the Economic Botanist, comprising the raising and testing of improved strains and the study of inheritance of characters. Good reports continue to be received of the varieties already selected, and not only has all the seed available with the department been rapidly taken up, but the growers in turn show an inclination to reserve their produce for sale for seeding purposes. Further selection work has resulted in the production of strains with definitely better cropping powers than the local varieties in the case of White Ottadam, Red Ottadam, White Samba and Kuruvai. Varietal tests intimately associated with the irrigation problem in the Godavari delta are in progress at Samalkota. The practice there is to raise a long duration variety in the first crop season and then after a short fallow to grow a short duration second crop. The latter is always liable to suffer from water scarcity and the solution of the difficulty probably lies in reversing the process. Varieties have been found which yielded quite well within 130 days from the time of sowing the seed-bed, while others which followed as a second crop have given an outturn of 3,300 lb. of grain per acre. More extended trials are, however, contemplated before recommending the general adoption of this practice. Work on linkage of characters has furnished further interesting results, some of which are of distinct economic value.

Experiments on the fields of private landowners with mineral phosphate applied along with green manure resulted in an increase of 271–412 lb. of paddy in soils analysing less than 0·01 per cent. of phosphoric acid.

The main feature of the year's work on paddy in BURMA was the reinstitution at Mandalay of plant-breeding and selection which had been discontinued for several years. In yield tests of Mandalay Ngasein (2104) and of Hmawbi Ngasein (10), the latter gave much better yields, but this type of rice does not find favour with Mandalay millers. Farmers recognize the decided superiority of Ngasein 2104 over local unselected varie-

ties and the problem now is one of mass production and distribution. At Hmawbi, Ngasein C 277, after several years' selection, was grown on 20 acres for distribution but unexpectedly developed awns of which there had been no previous indication. Some of the Byat paddies grown there gave outstanding yields, and one of the Pegu Ngaseins showed marked immunity from the attack of case-worms. A short-lived type of Japanese paddy (Hoito), which is expected to be particularly suitable for the dry zone tract, is being multiplied at Mandalay. Several series of experiments to find out the most suitable manure and the optimum duty of water for paddy are in progress.

In the investigations on the parboiling of rice, large scale tests showed that with solutions of sulphuric acid and calcium hyposulphate, costing only R. 1-4 per ton of rice, odours could be entirely suppressed. Samples of the rice so prepared have been sent for biological tests to England. Further experiments on breakage in milling led to the conclusion that rapid drying was an important factor in breakage and that steeping the paddy in very hot water will keep down odours as well as reduce very considerably the necessary steeping time.

The year's results in the CENTRAL PROVINCES indicate that the Gurmatia 13 and Bhondu 9 varieties are the most profitable rices for the greater portion of the rice tract in the Chhattisgarh and Nagpur Divisions. Being a medium rice which matures in four months and five days, BH 9 can be grown in areas where later kinds suffer in years of short rainfall. The yield of this variety exceeded that of medium *desi* rice maturing at the same time by 470 lb. of paddy (value Rs. 14) per acre. Of the early varieties tested, Bhata Gurmatia still continues to be the favourite. In the Northern Circle, where early rices are required, Dilbaxa 17 and 16 are the standard rices recommended by the Agricultural Department, but they may have to give way to still better varieties as the result of trials now being made on the Adhartal farm.

The year's trials indicated that sann-hemp on the Raipur farm yields a higher acreage profit as a manure for rice than cattle dung. The addition of bone-meal did not prove economical.

In ASSAM, single plant selections from 158 types of *aus*, 176 types of *sail*, 55 types of *asra* and 343 types of *aman* were under observation. The selected *aus* M 36/30, which is distributed to cultivators since last year, proved superior to local varieties in most places. Georgesail, Indrasail and Latisail, tested on a field scale against Chaprasail, a local variety, gave respectively increased yields of 737, 246 and 327 lb. per acre. All these three types are now being extensively grown in the Surma Valley.

Experiments with bone-meal on paddy have given very indefinite results and a new series of manurial experiments has been laid down.

The new strain of Kolamba rice developed at Karjat in BOMBAY yielded 29 per cent. above the local variety on cultivators' fields. Next year seed of this and one or two other strains will be available for about 3,000 acres. The actual kind, extent and time of the manuring which can give the most economical result with paddy is under investigation.

The work on paddy in BIHAR AND ORISSA has resolved itself into the selection of large numbers of single plants of promising types of paddy on all the farms in the province, and the multiplication of seed from these plants under careful observation with a view to the testing of the yield per acre of the most promising against similar but later ripening local types, for which the heavier yielders may be substituted with all round advantage. The Dahia paddy, selected at Sabour in this manner, has spread over some 5,000 acres in South Bhagalpur, and has also proved the best early paddy for Ranchi. One of the Ranchi selections, having given better yield than the popular Kalamdan, is being tested on a large scale. At Cuttack and Sambalpur, promising types of heavy yielding coarse paddy have been selected but their market value has yet to be ascertained.

Demonstrations carried out in selected villages in the application of phosphates with green manure previous to the transplantation of paddy have been successful in popularizing this practice in South Bhagalpur.

A preliminary survey of the rice crop and of the problems connected therewith has been started in the UNITED PROVINCES.

In the TRAVANCORE State, experiments designed to find out early varieties and suitable manures, to reduce the seed rate and to improve cultural operations are in progress.

DISEASES AND PESTS. A vigorous campaign was carried out in demonstrating methods of control of the Rice Hispa beetle in the South Kanara District of the Madras Presidency. In Assam, the ravages of rice grasshoppers were combated by the use of hand bags.

In some localities in Bengal the incidence of the Ufra disease is reported to have diminished owing to the improvement in drainage. Demonstrations in burning the straw on disease-affected patches as a remedial measure were carried out in the Noakhali and Comilla Districts.

## II. Wheat.

Wheat stands next to rice in area as a single crop in India. It is the main food staple of the people of Upper India, and is grown on about 10 per cent. of the total cultivated area of India. Owing to the good distribution of the monsoon in its later stages, the area rose from 25,783,000* acres in 1920-21 to 28,234,000 acres in 1921-22 and the estimated total yield from 6,706,000* tons to 9,813,000 tons. The production was thus 46 per cent. higher than in the previous year, the outturn per acre showing an increase of 196 lb. and 98 lb., respectively, as compared with that of the previous year and the average of the preceding ten years.

The replacement of the country wheats by more efficient varieties of better grain quality continues. It is estimated that in the two chief wheat-growing provinces of India (the United Provinces and the Punjab) over a million acres of improved wheats (Pusa 12, Pusa 4 and Punjab 11) are grown by the cultivators. Another testimony to the intrinsic value of Pusa wheats comes from Australia. At the 1921 Royal Agricultural Show at Sydney, two of them—Nos. 4 and 107—again took a first prize. Pusa 107 with a bushel weight of 68 lb. was the only wheat in the show which obtained the maximum number of

* Revised figures.

points, while Pusa 4 lost half a point on bushel weight but otherwise gained full marks.

The varieties hitherto issued from Pusa, though characterized by a stronger straw, a finer grain and a freedom from rust greater than the indigenous wheats, all lack the awn which is an asset of considerable importance in certain parts of the country as a protection against birds. There is thus a demand for a bearded wheat with high yielding qualities. A new series of bearded hybrids have been brought out at Pusa which give promise to equal, if not exceed, Pusa 12 in yielding power. Advantage is also being taken, in the United Provinces, of the fortuitous appearance in the crop of Cawnpore 13 wheat of a bearded type possessing in other respects the characteristics of the original.

Pusa 12, Pusa 4 and Cawnpore 13 wheats have received such wide acceptance in the UNITED PROVINCES that it is no longer possible to estimate the area under them and the work which falls on the department now consists mainly in maintaining a supply of pure seed. The number of seed depôts where the cultivator is able to purchase the best varieties is steadily increasing, and the Government have cordially accepted a resolution, moved in the local Council, that the ultimate aim should be the establishment of a depôt in every tehsil.

In the PUNJAB, the departmental selection Punjab 11 still holds the field though the more recent selection 8A is reported to be a better yielder. During the five years ending June 1922, the estimated sowings under Punjab 11 in the canal colonies have increased from 196,500 to 749,966 acres. 8A, however, is making specially rapid progress in the Lower Jhelum colony where it is expected to oust Punjab 11. Pusa 12 still continues to be a popular wheat on well-irrigated lands. In the neighbourhood of Panipat very high yields of this variety are reported. "It responds more to better conditions of cultivation and moisture than any other of our types, and there is no doubt that under such conditions it can seldom be beaten", writes the Deputy Director of the Hansi Circle.

In the short space of seven years from the date of its first distribution in the NORTH-WEST FRONTIER PROVINCE, Pusa 4

has almost entirely displaced the local wheats in the Peshawar District, and it is estimated that in 1921-22 it was sown on 150,000 acres. Nearly 100 varieties, which included most of the more noted wheats of the warm temperate parts of the world, were this year under trial at Tarnab. The Federations and Pusa 4 alone stood up and remained rust-free in the storms of wind and rain which occurred at frequent intervals after the 1st of March. The Punjab wheats lodged completely after the first storm and were among the earliest to be attacked by rust.

Of the varieties of wheat which have been under trial in the CENTRAL PROVINCES for the last five years, Pusa 100 and AO 89 have in the Chhattisgarh and Nagpur Divisions amply proved their qualities. When grown under ordinary conditions they can be relied on to yield 100 lb. more per acre than the local Kathia and Haura. Of the new wheats tried, Pusa 101, Pusa 54 and AO 113 are the most promising. On the Powarkhera farm, two Muria-Khapli crosses have given, over a period of three years, an average increase of 66 lb. per acre over the *desi* Pissi.

Ploughing in the hot weather or the very beginning of rains increased the yield of wheats by 50–60 per cent. on the experimental area at Powarkhera as compared with the local practice called bakhering. At Raipur over a period of five years one irrigation has given better results than two or more.

Selection work on wheat in BURMA has been transferred from Mandalay to Padu. In the Shan States, Federation and Pusa 12 were found to do best on low-lying areas and Pusa 4 on the uplands.

Further experiments with wheat sown in October after a crop of potatoes planted in June and lifted in September show that on manured land twice the yield got by ordinary Shan farming methods can be obtained.

Pusa 12 and Pusa 4 gave good results in some of the districts lying in the Burdwan and Rajshahi Divisions of BENGAL. They also did better than the local wheat at Murshidabad under irrigation. A system of roguing and mass selection has now been introduced on the departmental farms, and it is hoped to be able to distribute these varieties on a large scale next year.

The cultivation of Pusa 12 is being encouraged specially in the Patna and Gaya Districts of BIHAR. The experiment on the cultivation of Pusa 4 in the flooded tracts of Orissa, where the paddy crops had been destroyed at too late a stage to permit replanting, again proved successful. Notwithstanding the very late sowing and subsequent severe drought, Pusa 4 gave in some places 60 per cent. more outturn than the local wheat.

Pusa 12 and Punjab 11 have proved particularly suitable for Sind, and their extension is said to be only a matter of time. Pusa 4 is making rapid progress in North Gujarat where it gives sometimes no less than 50 per cent. more value than the local Wajia. In other areas of the BOMBAY Presidency, the North Indian selections have not been a success, but a number of types have already been obtained locally which show great promise of increased yield under Deccan conditions.

Propaganda for wider adoption of Pusa wheats is reported to be bearing fruit in the GWALIOR State.

DISEASES AND PESTS. The ear-cockle disease is responsible for damage estimated at lakhs of rupees in the Punjab. An effective remedy is to sow only properly cleaned seed. The demonstrations of this carried out during the year are said to have had a very convincing effect on the neighbourhood of the centres of demonstration.

In wheat experimental plots at Pusa suffering from the attack of an Aphidid, the effect of collecting and liberating Coccinellid beetles was tried with good effects. It is probable that the local custom of growing wheat intermixed with mustard is beneficial in this way, as the Coccinellids bred on the mustard Aphidids later on attack the Aphidids on the wheat.

### III. Sugarcane.

The area under this crop fell from 2,566,000* acres in 1920-21 to 2,381,000 in 1921-22, but the estimated yield of *gur* (unrefined sugar) increased from 2,522,000* tons to 2,591,000 tons. The outturn per acre works out at 2,439 lb. of *gur* as against 2,202 lb. in the previous year and the last decennial average of 2,327 lb.

* Revised figures.

During the year under review, India manufactured 73,113 tons of refined sugar in her 29 modern factories, an increase of nearly 6,000 tons over the output in the previous year. Together with her production of refined sugar by the indigenous process of sugar-making which is estimated at 50,000 tons, a total of 123,113 tons refined sugar was manufactured in the country.

The imports of refined sugar, both in quantity and value, reached figures unprecedented even in the pre-war era. They amounted to 718,000 tons valued at no less than 26¾ crores of rupees as compared with 237,000 tons valued at Rs. 17 crores in the preceding year and the pre-war average of 634,000 tons valued at Rs. 12½ crores. While a main contributing factor to the increased imports was undoubtedly the fall in prices, the fact that the country can afford to spend 26 crores of rupees in a by no means unusually good year should be a good enough guarantee of an assured market to capitalists desiring to promote the white sugar industry. The enhancement of the import duty from 15 to 25 per cent. and the rise in railway freights from the ports should give an additional impetus to the development of the home industry, and it is to be hoped that some at least of the nine new joint stock companies registered during the year for sugar manufacture will begin their operations at an early date.

Sugar is the only agricultural product in India in which the balance of trade is decidedly against her. Considering the area under the crop she should be at least self-supporting, and there is now sufficient evidence that, provided with the proper varieties of cane, and through adopting the right class of manuring, it would be quite possible to grow all the sugarcane required to meet the existing demands for both *gur* and white sugar on the present area. The problem would thus seem to resolve itself into this: is it possible to have a *gur*-making and white sugar industry alongside each other in the cane-growing areas? Otherwise it is at present quite out of question for the grower to deal with a large increase in outturn except by reducing his area.

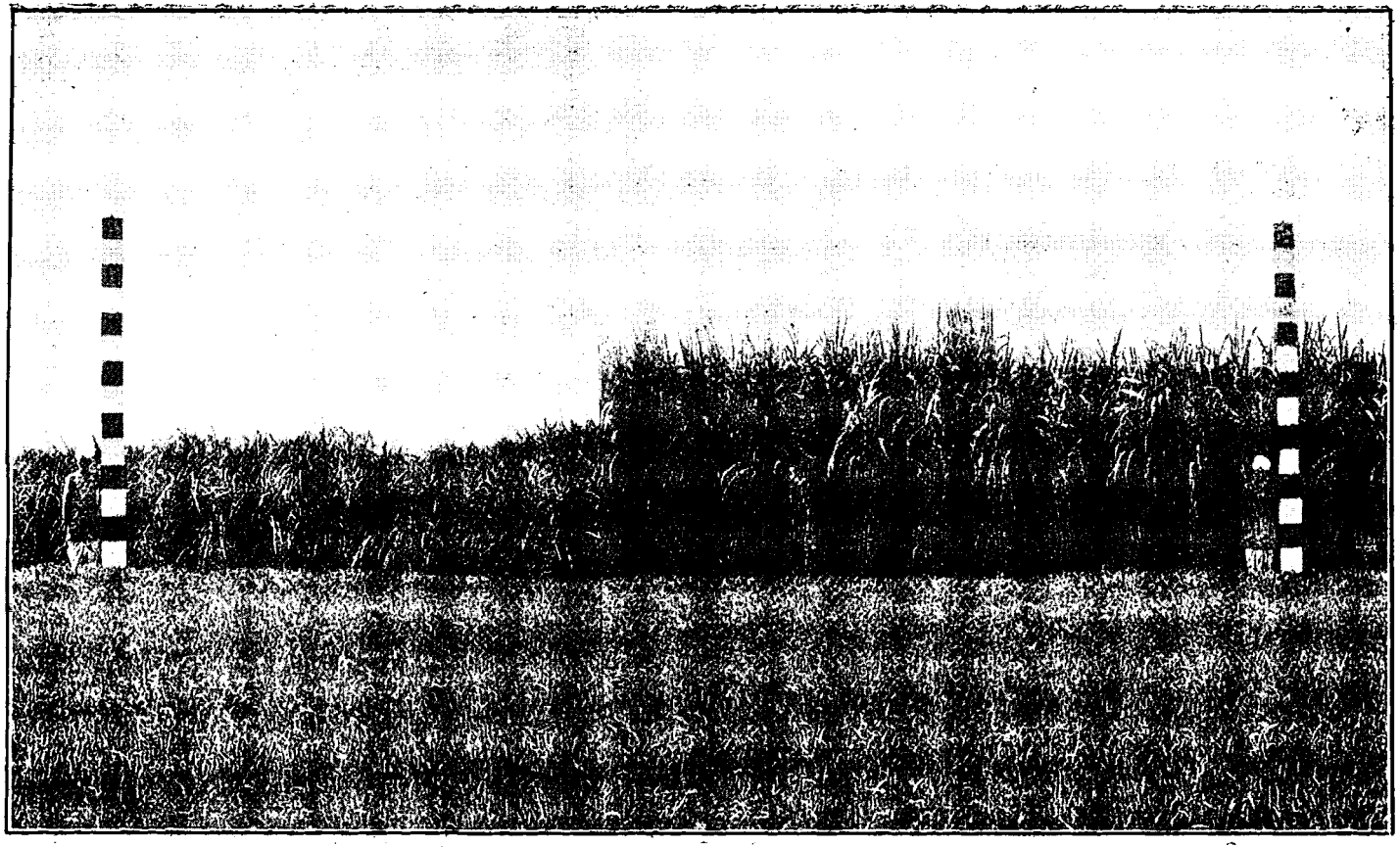
The hope of effecting the desired improvement in outturn through improved varieties has received a remarkable stimulation by the results of the work of Dr. C. A. Barber, late Imperial

Sugarcane Expert, at the Coimbatore Cane-breeding Station—results which are just beginning to show the enormous possibilities in this direction. For example, one of the Coimbatore seedlings (Co 205) is already giving 60-80 per cent. higher yield of *gur* to the acre than the best local canes in the Punjab. The most important development is, however, expected in Bihar where the early ripening qualities of Co 214 and the high tonnage, combined with good agricultural characters, of Co 213 will not only enable the large number of sugar factories situated in this province to open their campaign at least a month earlier, and so provide them with a longer working season, but also increase the supply of the raw material.

In North Bihar sugarcane is grown without irrigation and has to go through several months of intense heat and drought before relief comes with the monsoon. The Coimbatore types referred to above are not only good drought-resisters but thrive uncommonly well in the dry heat. They have also proved themselves excellent doers in low-lying semi water-logged areas, due, apparently, to the start they make before water-logging conditions are established (Plate I). Co 213 is especially vigorous and stands heavy manuring without lodging. The best acre at Pusa this year ran 1,600 maunds or nearly 60 tons of good quality cane without any lodging whatever and without trench planting—an important consideration in Bihar (Plate II).

The SUGAR BUREAU established at Pusa continued to carry on its principal function of supplying information to the sugar industry in all its aspects, and of promoting of sugar growing in India generally. It has also recently taken over the testing and multiplication of improved varieties for the surrounding district and of arranging mill trials of the more promising varieties. The first trials of the new seedlings have been quite satisfactory, and both factories and growers are doing their utmost to assist in the rapid propagation of Co 213 and 214 as it is recognized that these will, if they continue to maintain their reputation, revolutionize the industry in Bihar.

Over half the total area under the crop in British India lies within the borders of the UNITED PROVINCES. Experimental work was continued at the Shahjahanpur Research Station.

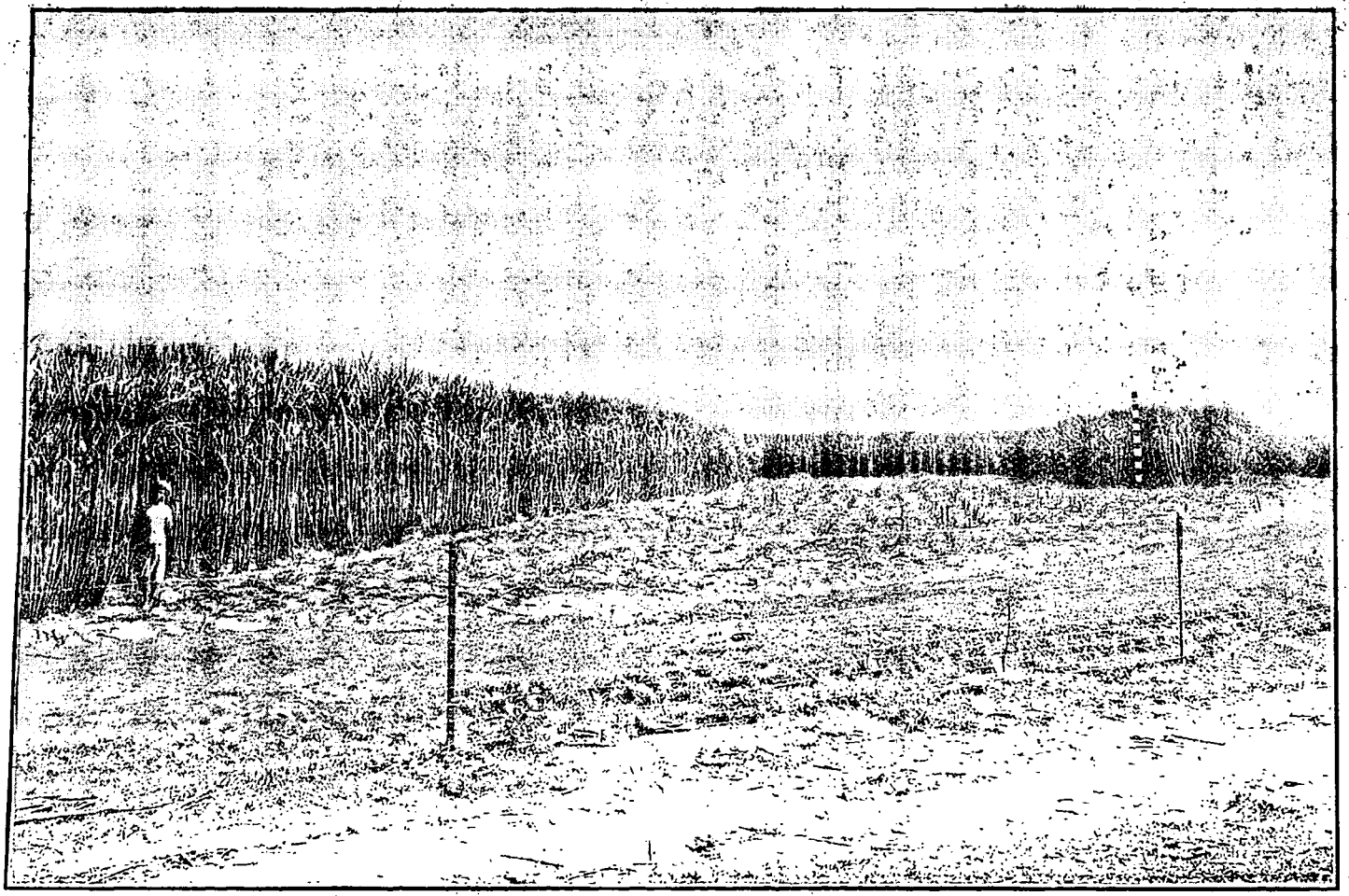


Hemja (10 tons per acre). Co 213 (30 tons per acre).

PLATE I.

A COMPARATIVE VIEW OF A LOCAL CANE AND THE COIMBATORE SEEDLING CANE 213 ON WATER-LOGGED LAND AT PUSA.

(Rainfall 62·96 in., Jan.—Dec. 1922. The measuring rod is 15 ft. high and each division shows one foot. The bottom 1 ft. is hidden from view by the crop in the front.)



A GENERAL VIEW OF CO 213 CANE GROWN ON A LARGE SCALE WITHOUT IRRIGATION AT PUSA.

PLATE II.

Three distinct lines are being followed in obtaining canes suitable for the various types of cultivation practised, *viz.*, the importation of canes from other countries, the investigation of Coimbatore seedlings, and the isolation of pure lines of indigenous canes. All of them have given definite results, and three canes (S 48, Co 214 and A 42), which possess qualities justifying their introduction, have been selected. A 42, a thin cane which matures early, is in great demand both on account of heavy yield and the excellent quality of its *gur*. The selected Coimbatore seedling is also an early ripener and can be intensively cultivated without deterioration in quality. It, however, gives a slightly darker *gur* than the best canes and arrows freely, which is not liked by cultivators. A field of 3·3 acres grown with S 48 gave last year *rab* which was sold for Rs. 3,280.

The improved methods of cultivation worked out on the farm are being gradually adopted where facilities exist for irrigation. The pofitable cultivation of cane in this province is primarily a question of water, and, with the introduction of the Sarda Canal, a large extension of cane in Rohilkhand, which is to be organized as a distinct agricultural circle, may be anticipated.

As the result of observation and chemical analysis all but 24 of the large number of varieties of cane grown at Sipaya in BIHAR AND ORISSA have been discarded, and the remainder are being tested with a view to further elimination and to discovering their response to manuring and to different methods of cultivation. Of the Coimbatore canes, Nos. 214, 213, and 210 are promising for early, mid-season and late cutting. These canes are being rapidly multiplied for distribution in North Bihar. Among the earlier tested canes, Saretha is the heaviest yielder of sucrose and has become popular among cultivators in the neighbourhood of Sipaya. At Ranchi, varietal tests of thick canes are in progress on thoroughly drained land. Java Hebbal was found last year to have the best sugar content, and, as it is among the hardy heavy yielders, it may displace J 247 for distribution. Co 213 promises exceedingly well as a drought-resister and heavy yielder, and the Pusa experience of its capacity to stand water-logging has been confirmed. The Mungo variety is gaining ground in the Orissa Circle.

An increased inclination towards sugarcane cultivation is reported from BENGAL, but irrigation difficulties in most areas would appear to limit the rapid expansion of the crop. Yellow Tanna has now established itself as an all-round superior cane, and the demand for sets is so great that it is impossible to cope with it.

The McGlashan furnace from the Central Provinces, when tried at Dacca, proved more economical in fuel than the local type. An adaptation of the design to suit the date sugar industry has been brought out.

In ASSAM, the testing and selection of varieties (local and exotic) under chemical control was continued at Jorhat. In addition to the four varieties previously selected (Striped Mauritius, B 147, B 376, and J 33*a*), two new ones, Co 9 and D 74, were this year distributed for the first time. Twenty varieties ratooned on the farm gave an average crop of 25 tons per acre, the highest yield being from B 3412. The same cane also topped the list as a plant crop with an outturn of 45·8 tons. But as regards quality, A 2*a* returned the highest record of sucrose in the expressed juice, closely followed by Co 9. Of the new varieties, A 2*a* and Co 9 promise to be valuable to sugar estates, while D 74, J 213 and B 3412 should do well with the ryots' conditions.

The 3-roller iron mill and the shallow iron pans are both gaining in popularity.

A new development in BURMA is the proposed sugarcane farm at Pyinmana. Of the eight exotic and two indigenous canes under trial at Tatkon, Java Hebbal, J 213 and Ashy Mauritius did particularly well. The latter was also most successful of the 13 exotic and two Burmese varieties grown without irrigation at Hmawbi, and all available cane of this type was sold for seed. The cultivation of sugarcane is rapidly extending in Shwebo, Sagaing and Mandalay.

The departmental *jaggery* factory near Hopin has been dismantled as the locality has been found unfavourable for such an enterprise, and it is hoped to find a more promising centre for future experiment either in Yamethin or Toungoo.

In the PUNJAB, the Coimbatore seedling 205, which did so well last year at Gurdaspur, has repeated its performance at Hansi.

At Tarnab in the NORTH-WEST FRONTIER PROVINCE, 246 Assam Red has proved a better variety than the local Pounda. It flourishes with less irrigation, it yields better, it is less affected by cane borers and withstands frost as well as the Peshawar variety. Having a hard rind it is not attacked by the jackal, and at the same time its seed keeps perfectly in the clamp. About 150 tons of sets have been given away for trial in the neighbourhood, and 15 acres are being grown this year for further distribution.

The long continued work at Manjri in the BOMBAY Presidency on the testing of new varieties is now bearing fruit. One of the selections (Manjav) is proving itself of great value for water-logged areas under the canals in the Ahmednagar District, while another (Red Mauritius) is rapidly displacing the local variety in Kanara, on account of the facility with which it gives high yields in the ratoon crop. In South Surat, several of the Manjri types are in keen demand to replace the local Malbari as they give higher yields and are less susceptible to red rot. Sulphate of ammonia, which has proved cheaper, value for value, than any other nitrogenous manure, is rapidly growing into use, its consumption in the Deccan being now between one and two thousand tons per annum.

As recommended by the Sugar Committee, experimental work on cane in the CENTRAL PROVINCES is now confined to the Tharsa farm. Of the varieties received from Coimbatore, Nos. 204 and 210 topped the list in the varietal tests; they gave yields of 8,200 and 7,330 lb. of *gur* per acre respectively.

The results of the manurial experiments show that for this crop a heavy dressing of dung or other bulky but slow-acting manures does not by itself give a maximum crop. To get a really bumper crop it is necessary to supplement it with a top-dressing of oil-cake, sulphate of ammonia or other quick-acting nitrogenous manure. Compost made on the Adhartal farm from weeds, the sweeping of the threshing floor, road scraping, etc., proved a valuable manure for the crop.

Varietal tests carried out in co-operation with cane-growers in the Circars have established the superiority of J 247 over previous importations made in the MADRAS Presidency. Java Hebbal has proved itself equally promising in the South Arcot cane area as well as on the West Coast.

In manurial trials at Anakapalle and Samalkota, fish guano established its superiority.

A cheap and efficient method of propping sugarcanes against lodging during heavy winds has been adopted at the Sugarcane-Breeding Station through the adoption of galvanized wire in the place of trash and rope.

Sugarcane breeding work has furnished the MYSORE State with at least one cane of outstanding merit, *viz.*, HM 544. It is now grown in practically all the main sugarcane areas, and is estimated to give increased yields of Rs. 150-300 per acre A number of other seedling canes are under comparative test on a fairly large scale.

Ammonium sulphate has been found to be a cheaper manure for sugarcane than any of the oil-cakes at present prices, and its popularization is being energetically carried on.

In TRAVANCORE, Red Mauritius continued to give the highest yield on the State farm. The manure recommended to the ryots is a mixture of oil-cake, fish guano and ashes.

The borer is the most serious PEST of the sugarcane crop. Trapping of the moths in heaps of trash is carried on successfully in some localities, but against pests which possess means of rapid dispersal only concerted action on an extensive scale can bring relief. At Pusa, termites attacking growing sugarcane were checked by the application of crude oil emulsion with the irrigation water.

## IV. Cotton.

During the year the area under this crop fell to 18,436,000 acres from 21,341,000* acres in the preceding year but the total estimated yield rose to 4,463,000 bales from 3,601,000* bales of 400 lb. each. The yield per acre was 97 lb. as compared to 67 lb.

* Revised figures.

in the preceding year. The quantity of raw cotton exported during the year ending 31st March, 1922, was 2,981,000 bales as against 2,074,000 bales in 1920-21. The value of cotton goods exported was Rs. 16,17 lakhs.

India stands second only to America in total area and production of cotton and, with the recent fall in area and yield of the American crop, tends to become more important in the world's market. Although the year 1922 has shown a marked recovery in the American cotton area the yield is disappointing and indicates that success in controlling the boll weevil has not been up to expectations. There is every indication that the American crop of the future will be some two million bales less than we have been accustomed to expect. Only a relatively small proportion of the Indian crop is capable of replacing American cotton even if properly marketed and handled. Indian mills take now over two million bales of cotton annually, which is approximately half of the average Indian cotton crop, but they are absorbing 80 per cent. of the present supply of Indian cotton of good staple, and increased production and better handling of long-staple Indian cottons and the prevention of adulteration are essential to the further continued development of the Indian spinning industry. On the other hand, India has a large exportable surplus of its shortest staple cottons, averaging 12 lakhs of bales, which has been as high as 2 million bales during the last seven years. There is little evidence to show that the world's markets can absorb regularly any larger quantity of cotton of below $\frac{7}{8}''$ staple; on the contrary the tendency everywhere is in the direction of finer spinning and a demand for better cotton. The present therefore offers an unrivalled opportunity for placing Indian cotton production on a sounder basis. As in past years, the work of the Agricultural Department has been chiefly directed to increasing the yield per acre and improving the quality of the production, and considerable success has already been achieved, but the time has come for a more definite effort.

The Indian Central Cotton Committee since its inception has held three meetings, in addition to a number of meetings of sub-committees appointed to consider special problems. Their first report, which covers the period up to August 1922, thus

corresponding with the close of the cotton year, affords ample evidence of the advantage of a joint meeting-ground for all sections of the trade with those engaged on the improvement of cotton cultivation. The Committee first directed its attention to the improving of marketing and the prevention of existing abuses which in the past have been largely responsible for unsatisfactory market organization. Dealing first with the recommendations of the Indian Cotton Committee, they were asked to advise the Government of India on that Committee's proposals in regard to the restriction of transport and the regulation of gins and presses. Their recommendations on the first subject have been accepted by the Government of India, and a bill on the lines recommended by the Committee has passed the second reading in the Indian Legislature and, it is hoped, will come into force within a few months. This bill differs from the original recommendation of the Indian Cotton Committee in that instead of attempting to restrict cotton transport throughout India, involving a complicated system of licenses, the present bill takes the form of an enabling Act empowering Local Governments (with the assent of their own Legislatures) to notify for protection definite areas of superior cotton, and to prevent the importation into the notified areas of any other cotton, waste, *kapas* or cotton seed. The Central Cotton Committee has been informed that the Bombay Government intends to apply the Act to two important areas of long-staple cotton in Bombay so soon as passed. The mixing problem is equally urgent in Madras where the efforts of the Agricultural Department and its establishment of a superior type of Northerns cotton are being seriously threatened by the importation of Cocanadas cotton into Nandyal. These importations during the present year have amounted to 21 per cent. of the total average Northerns arrivals at that important centre. Early action is also necessary both in the Tinnevelly and Cambodia areas, and the matter is receiving the careful attention of the Madras Provincial Cotton Committee.

The Central Cotton Committee was unable to recommend the universal application of the Indian Cotton Committee's scheme for the licensing of gins and presses. It, however, strongly supported the essential features of the scheme, *viz.*, the compul-

sory marking of bales, records of ownership and compulsory statistical returns, and has advised the Government of India that central legislation is necessary to provide for these requirements. It has also recommended that such legislation should include enabling clauses empowering Local Governments to frame rules, with the assent of their own Councils, for the better regulation of gins and presses. These proposals are still under consideration with a view to legislation.

The Central Cotton Committee has also examined various aspects of the cotton marketing problem. The Bombay Government has now under consideration the early introduction of legislation to provide cotton markets on the lines of the Berar markets, and the Madras Provincial Cotton Committee has urged the Madras Government to introduce enabling legislation for the same purpose at an early date. Considerable progress has been made in respect to co-operative marketing associations, and the conditions necessary to success have now been more clearly defined.

Local market organization is principally a matter for Provincial Departments of Agriculture and Provincial Cotton Committees, and the functions of the Central Cotton Committee are advisory. The latter Committee, however, has been impressed with the need for constructive action towards the improvement of cotton marketing. It has received most definite information that it is impossible under present conditions to take steps to induce cultivators to market their cotton in a cleaner condition, as under existing market organization there is insufficient inducement for them to do so. Similarly, as at present organized, local markets offer entirely inadequate premia for improved staple except in tracts with an established reputation. The question of the trade classification of cotton has, therefore, been taken up in conjunction with some of the Directors of the East India Cotton Association, and the Standing Local Sub-Committee is at present engaged on the examination of this important question, directing its attention in the first instance to possible changes in the Bombay rules and standards, which would afford a definite incentive to the delivery of better cotton at all stages in its journey from the field to the mill. The Central

Cotton Committee has already been assured by the President of the East India Cotton Association of the cordial support of his Board in promoting any practical measures to this end.

The necessity for more agricultural research for the improvement of cotton growing has repeatedly been urged and was emphasized by the Indian Cotton Committee. Whilst recognizing the value of the work which has already been done by the Agricultural Departments and that, despite financial stringency, several Local Governments have made increased provision for work for the improvement of cotton growing, it is obvious that Provincial Departments of Agriculture with their present organization and resources cannot cover the whole field. The Central Cotton Committee has, therefore, advised the Government of India that a central fund for cotton research is necessary, and to provide for this it has advised the levy of a cess of four annas per bale on cotton exported from British India by sea and cotton consumed in spinning mills in British India. This proposal has received, so far as the general principle is concerned, the unanimous support of all Local Governments, although there has been some difference of opinion in regard to details. The majority of Local Governments have supported the Central Cotton Committee's proposals *in toto*, and these proposals have also received the very cordial support of Chambers of Commerce and Millowners' Associations. The proposed cotton cess would produce some eight to nine lakhs of rupees per annum which would make possible a study of the many problems of more than local or provincial importance which are at present untouched.

The Indian Cotton Committee also recommended that the Central Cotton Committee should employ a technologist, who would carry out tests on new cottons for Agricultural Departments and obtain satisfactory valuations. The lack of such facilities in the past has led to undesirable types of cotton being brought into cultivation on a large scale. This recommendation was endorsed by the Board of Agriculture in India, which further recommended that the technologist should be provided with an experimental spinning plant. These proposals have been examined in more detail by the Central Cotton Committee

and a definite scheme formulated for technological research including—

(1) the testing of new cottons for Agricultural Departments;

(2) the study of the characters of the various Indian cottons with a view to eventually providing a sound basis for trade classification (a line of work which has recently proved very fruitful in America); and

(3) investigations into the relation between the physical characters of Indian cottons and their spinning characteristics.

As a result of the deputation of the Secretary to England for the purpose for a short period, the Indian Central Cotton Committee has been able to furnish definite estimates of cost and has recommended to the Government of India that a small technological research department should be started in Bombay and financed from the cotton cess funds.

The Committee's recommendations in regard to the cotton cess have been accepted by the Government of India and the necessary legislation will be introduced at the earliest opportunity.

The Central Cotton Committee has also started an information bureau and has taken in hand the collection and supply of trade and agricultural information in respect to cotton. It has also been able to secure the more speedy supply to the cotton trade of information in regard to progress in different provinces, particularly in respect to the establishment of superior strains, and has also been able to supply trade information of value to the Agricultural Departments. The recent bulletin on the demand for various types of Indian cottons, the compilation of which has been made possible by the very generous response of mills and exporters to requests for information which in the past has been treated as confidential, has enabled certain important conclusions to be drawn which should be of distinct value to Provincial Departments of Agriculture in deciding on their own future policies in respect to cotton development. Whilst the information received is incomplete from a statistical standpoint,

it covers the ground sufficiently to demonstrate clearly the trend of export demand and the requirements of Indian mills.

Provincial Cotton Committees have now been established in all cotton-growing provinces with the exception of Bombay where a scheme for divisional committees is now under examination. In Madras local cotton committees have also been formed. These committees form the necessary connecting link between the Central Cotton Committee and the provinces, provide the Central Committee with local information which it would otherwise be difficult to obtain and enable the Central Committee to keep the province in touch with progress in all parts of India. These Provincial and Local Committees, which follow closely the lines recommended by the Indian Cotton Committee, will become of ever-increasing importance in view of the measures which are now being taken for the checking of adulteration and improvement of marketing.

The BOMBAY Presidency with an area of over 5 million acres of cotton (which is some 28 per cent. of the cotton grown in India) has four very distinct cotton-growing tracts, each having its own problems, or five if Sind is included. For some years past the policy of the department has been the isolation of pure strains and the introduction of these into general cultivation, and very considerable success has been achieved in the long staple areas of Southern Gujarat (Surat-Broach) and in the Southern Mahratta Country (Kumpta-Dharwar tract).

The degeneration of the Broach crop, due to the invasion of the short-stapled *herbaceum* cotton known as Goghari from the north, and the constant importation of short-stapled cottons for mixing, had reached such a pitch that in 1920 the Cotton Contracts Board found it necessary to exclude Broach from the staple cotton contract. Attention was first concentrated on the purification of the crop in the Surat District which has always been of superior staple. Pure types of Surat cotton from the central farm at Surat were distributed in an organized manner, and the department now controls 18,000 acres of private seed farms which are supplied with seed and regularly inspected and rogued. The department has organized special auction sales for the cotton from these seed-production areas,

resulting in a satisfactory price to growers. The seed is in keen demand and, for the 1922 season, the Agricultural Department has distributed seed for 2 lakhs of acres, and it is estimated that a further 2 lakhs of acres will be under the same selection from uncontrolled seed. A survey of the purity of the crop of Surat cotton shows that, generally speaking, Goghari cotton has been largely eliminated, the percentage in 5 tehsils now having fallen to below 8 per cent. as compared to figures as high as 35 per cent. in 1919-20. Independent information from trade sources confirms the view that a very considerable measure of success has been achieved in the re-establishment of Surat cotton. In the north of Broach District progress has not yet been rapid but results are encouraging.

In the Kumpta-Dharwar tract, the department has established on a considerable scale a pure type of Kumpta cotton and a selected Dharwar-American (of the rough-leafed Upland type), both of which are a marked improvement on the ordinary crop. The department from its own farms organizes a supply of sufficient seed of 10,000 acres of each variety, further extension work being carried by co-operative seed societies and co-operative sale societies; the latter in this area have achieved a marked success and are most important factors in the improvement of cotton growing in that tract. The areas sown with seed of known purity in 1922 are established at 35,500 acres of Gadag I, 38,000 acres of Dharwar I and 5,000 acres of Dharwar III. Gadag I is an Upland American selection; Dharwar I and Dharwar III are improved types of Kumpta cotton.

In Khandesh, which is a short staple cotton tract at present growing a cotton somewhat inferior to Oomras, the distribution of *Neglectum roseum* seed has been continued as it is in demand amongst growers, but work is in progress for the production of a better type of cotton.

A cotton-breeder has now been stationed in each of the four tracts of the presidency proper. Work in Northern Gujarat, the Dholleras area, is only just beginning. In Khandesh the isolation of pure strains from existing Khandesh cottons has been taken in hand, and while these appear to be equally

prolific with *roseum*, they are of distinctly better quality. If these results are confirmed it will be possible, by a similar organization to that in Gujarat, to effect a marked improvement in the quality of Khandesh cotton. Further selections from the cross made some years ago between Bani and Comilla cottons are being made and show promise. Both at Surat and Dharwar further plant-breeding work is in progress, as it is considered that by hybridization even better types can be obtained. Such work is most advanced in Dharwar, and one of the types obtained has a staple equal to the best Kumpta, a pure white colour and a ginning percentage of 33 as compared to 27 for Kumpta.

It is as yet too early to say whether these new types are pure enough for multiplication for seed supply, and as the department has useful types for distribution in these areas there is every reason for caution and adequate testing before the introduction of fresh types is undertaken.

In Sind there has been a distinct increase in the area of American cotton which is now reported to have reached approximately 7,000 acres as compared with 3,000 acres in the preceding year. A selected strain of Sind *desi* cotton known as 27 W N yields 16½ per cent. more lint per acre than ordinary Sind cotton. The question of the future of cotton research in Sind is still under consideration, and the policy finally adopted must largely depend on the decision reached in regard to the construction of the Sukkur Barrage and the extension of canal irrigation. It has already been shown that in no part of India are there such possibilities for the growing of long staple cotton under irrigation as in Sind. A qualified cotton-breeder has recently been appointed to this division.

Amongst the present cotton problems, which the Bombay Agricultural Department consider should receive immediate attention, but for which no funds are available at present, may be mentioned physiological work into the causes restricting yield in Gujarat and the loss of crop by boll and bud shedding, wilt on cotton in the Kumpta area and further and more detailed plant-breeding work on the Upland American type.

The MADRAS Presidency, although it produces a relatively small proportion of the cotton grown in India, is of peculiar

importance in that practically the whole of it is long-stapled cotton of extreme importance to Indian mills. Work on the introduction of improved varieties has been continued on existing lines.

The local cotton in the " Northerns " tracts is a mixture of " red " and " white " cotton. Nandyal 14 is a white cotton of good length and strength evolved from the local cotton. Seed of this strain sufficient for about 8,500 acres has been distributed in the Kurnool District. It yields 25 lb. of *kapas* per acre more than the local mixture and is expected to command a premium of Rs. 50 per bale.

The local cotton in the " Westerns " tracts is a mixture. Hagari 25 is an improved strain of the local cotton which yields 13 lb. of *kapas* per acre more than the local mixture and commands a premium of Rs. 13 per bale. Seed of this strain sufficient for 12,800 acres has been distributed in the Bellary District.

In the case of Nandyal 14 and Hagari 25 cottons, the natural expansion in the cultivation of these varieties without the intervention of the department has not been taken into account.

The local cotton in the Tinnevelly tract is a mixture of Karunganni and Uppam. Improved strains of Karunganni, known as Company cottons, have been evolved at the Koilpatti farm, and these are now grown as pure crops on a large scale. They yield more than the ordinary mixture, have a higher ginning precentage and a longer and finer staple. The area under Company cottons is estimated at 200,000 acres in the districts of Madura, Ramnad and Tinnevelly. The gain is estimated at Rs. 25 per acre. The total gain is thus Rs. 50,00,000.

Company cotton is also replacing rain-fed Cambodia and Uppam on the dry lands of Coimbatore, where it is found to be a better yielder. The gain is estimated at Rs. 30 per acre. Seed sufficient for 4,000 acres was distributed by the department in the Coimbatore District. The natural expansion of the cultivation of Company cotton is really much greater, being variously estimated at from 20,000 to 40,000 bales (of 400 lb.), representing the produce of some 80,000 to 160,000 acres.

Cambodia cotton is an exotic, being a type of American Upland obtained from Cambodia, and was introduced by the department in 1904. There are now 2,800 acres in Salem, 87,300 acres in Coimbatore, 1,730 acres in Trichinopoly, 9,000 acres in Madura, 14,556 in Ramnad and 3,127 acres in Tinnevelly, *i.e.*, a total of 118,513 acres.

Cambodia is cultivated mainly on land which had previously yielded precarious crops of paddy, on very favourably situated dry land, and on garden lands where it has been introduced into the rotation of crops. Thus it supplanted crops the average profits of which could not have been more than Rs. 40–50 per acre. It requires less irrigation than any other garden crop. A good crop on irrigated and heavily manured land will yield 500 lb. and more per acre of lint which is superior to indigenous cottons in quality and price. On a modest estimate, a net profit of Rs. 120–130 per acre can be obtained which is Rs. 80 per acre over the crops that would otherwise be grown. This estimate applies to the Coimbatore District where the standard of farming is high. In the other districts, there would be a gain of at least Rs. 60 per acre. The total gain on the whole is estimated at about Rs. 88,57,000.

There are 1,500 acres in Salem, 20,000 acres in Coimbatore and 1,000 acres in Trichinopoly, or a total of 22,500 acres under improved strains of Cambodia, yielding 25 lb. of *kapas* per acre more than ordinary Cambodia of superior staple, and there is also a reduction in seed rate on account of the better quality of the seed. The gain is estimated at Rs. 10 per acre, or a total of Rs. 2,25,000.

There are 400 acres under improved strains of Cambodia in Madura and Ramnad, estimated to yield an additional profit of Rs. 5 per acre on account of the superiority of the lint over ordinary Cambodia.

The work of the Agricultural Department is, however, being made unnecessarily difficult by the importation of inferior cottons for mixing which has already been referred to. Unless early action is taken to check this there is very serious risk that much of the department's work will be entirely thrown away.

Research work by the Cotton Specialist has been largely directed to the improvement of Cambodia cotton by selection. The inheritance of characters in crosses between *G. neglectum roseum* and *G. indicum* are also being studied.

The area under PUNJAB-American cotton has declined during recent years, although still approximately half a million acres. The yield in 1919 was unsatisfactory but an imrovement was recorded in 1920 which, combined with good prices, encouraged sowings for the following year. For the greater part of the canal colonies the 1921 crop was most unsatisfactory in regard to both quality and yield. This presents one of the most important cotton problems in India at the present moment. Punjab-American cotton is by far the most outstanding example of the replacement of short staple cotton by a cotton of approximately 1″ staple, but this success is now seriously threatened. The causes for the unsatisfactory yield are not fully understood.

A more recent selection, 285 F, of longer staple than 4 F and of somewhat better habit, has shown great promise on the Lower Bari Doab canal, but it is by no means established that it is suitable to the Lyallpur District or that it will afford a final solution of the problem. It is hoped that during the coming year the Central Cotton Committee will be able to give effect to the proposals which it has made for the study of this most urgent problem.

In the UNITED PROVINCES it has been necessary this year to restrict the Cawnpore-American cotton known as CA9 to one canal distributary. Very great difficulty has been experienced in arranging for an adequate supply of canal water for American cotton sowings, and there has unfortunately been reduction in the special canal supply arranged for in previous years. The estimated area for 1921-22 was 5,131 acres as compared to 3,380 in the previous year and 8,100 in 1919.

The pure line selection from the Bundelkhand *desi* cottons known as J N 1 is in keen demand. Up to the present, distribution has been restricted to non-irrigated districts (or to districts with an indifferent canal supply) but, in view of the

revision of the canal programme for American cotton, distribution has now been extended to the Etawah, Mainpuri and Fatehpur Districts. This cotton is well adapted to either irrigated or non-irrigated sowings, has been repeatedly tested and well reported on by local mills, and is suitable in Cawnpore for spinning counts of 16s warps and 20s wefts at any time and for 18s warps during the monsoon. This cotton is of $\frac{7}{8}''$ staple. Originally intended for Bundelkhand, it seems probable that it will be extensively grown in the Lower Doab, and, although inferior to American in spinning value, is nevertheless a great advance on the local cotton which has a staple of $\frac{5}{8}''$ and is only suitable for counts up to 12s.

In the Muttra District satisfactory results are reported from what is now known as the "Raya" selection from the hybrid K 22. Demand for seed is reported to be keen and sufficient for approximately 1,000 acres has been issued in the neighbourhood of the Raya cotton farm. Research work on Mendelian lines and the examination of cottons obtained during the course of the cotton survey have been continued though much hampered by shortage of staff. Proposals for a special cotton research section are now under consideration.

The principal distributions of seed in CENTRAL PROVINCES AND BERAR are still of the *roseum* type and sufficient seed for 300,000 acres has been issued for the current crop. This province has always been faced with the difficulty that it has indigenous cottons of superior staple giving low yields and low ginning percentages, and, as the yields throughout the province are, broadly speaking, the lowest in India, agricultural yield has been of primary importance. The cotton known as Sindewahi Cross, however, shows considerable promise and seed sufficient for some 1,300 acres has now been issued. At the Akola farm it yielded exceptionally well and was valued at Rs. 90 per bale above C. P. Jari. It is calculated that, if this premium which means Rs. 22 per acre can be maintained, an area of 100,000 acres could be established in three years. Seed for about a thousand acres of Buri cotton was distributed in Berar, whilst Cambodia cotton is still under trial in the Nagpur and Chanda Districts. The question of securing a cotton equal in yield to

*roseum* but with less undesirable spinning characters has now been seriously taken up, and, as the province once more has an Economic Botanist, who is chiefly directing his attention to cotton research, more rapid progress is hoped for. The bulk of the Central Provinces cotton is now but little better than Bengals, owing to the gradual disappearance of the longer-stapled constituents of the mixture, but there is every reason to believe that much better types than *roseum* could be grown.

The Akola farm has now been definitely set aside as a cotton station for research work in cotton and crops grown in rotation with cotton.

In BURMA, considerable progress has been made with the survey of indigenous cottons and the Wagale crop has been studied in more detail and some promising selections have resulted. Of the Wagyi selections, one showed exceptional merit with a staple of $\frac{3}{4}''$ length, and is being tested further. Crosses between Shan and Wagale, Broach and Wagyi and Shan with Burma cotton are being further studied. Cambodia cotton is being grown experimentally in Sagaing, Monywa and Thayetmyo, and continues to show promise though the last season was most unfavourable. Cambodia has shown to be unsuitable for Tatkon and its cultivation there has been discontinued. The farm ginneries at Mahlaing and Allanmyo ginned considerable quantities of cotton for growers of the Agricultural Department's seed and the facilities thus provided were much appreciated.

In BENGAL, some difficulty is being experienced in connection with the proposed cotton survey, as many districts report that no cotton is grown on a field scale. It is interesting to note, however, that a type of plant has been found at Dewanganj which is similar to the one described many years ago by Dr. Roxburgh as the Dacca muslin cotton, and seeds have been secured.

In ASSAM, a survey of indigenous cotton varieties is now being started as a basis for future work.

In MYSORE, plant-breeding work on the local Sanahathi cotton has led to the production of two types (Nos. 45 and 69)

which are well reported on by mills and promise a considerable improvement in yield, and seed has now been issued for 250 acres. Work on Dharwar-American cotton (Doddahatti) is not so far advanced but extended trials are being undertaken during the coming season.

The cotton-growing areas of BARODA are almost inextricably mixed with adjoining areas of the Bombay Presidency. For some time the two departments have co-operated to ensure the establishment of uniform types in adjoining areas of their territory. In the past the Bombay department has supplied the Baroda State with the necessary selected seed, the State undertaking propaganda work which has resulted in the establishment of 22,000 acres (14,676 of known purity) of a selected type in the Navsari District. The Baroda Agricultural Department has now two seed depôts of its own and controls 300 acres of special seed areas.

The HYDERABAD State has continued and extended its improvements and successful operations for the replacement of mixed cotton by the Bani (Hyderabad-Gaorani) type. This crop was estimated at 420,000 bales last year and has averaged 324,000 bales during the last four years. In the two administrative districts of Nandyal and Parbhani the crop is said to be pure Bani, and these districts produced last year 343,000 bales. The Agricultural Department controls seed sufficient for the production of 180,000 bales. The State is also taking measures for the prevention of transport of cotton from one part of the State to another for mixing purposes. Hyderabad-Gaorani from the best areas is at present one of the most valuable cottons in India to spinners and is keenly competed for. The market value of the crop is, however, considerably lowered by the condition in which it is marketed, resulting in a high blow-room loss in the mill. It is understood that several important purchasers have now completed arrangements for installing their own ginning factories in Hyderabad which will considerably reduce this loss. Practically the whole of this crop is taken up direct by mills and but little comes on to the Bombay market.

The study of the INSECT PESTS OF COTTON in India does not fall under any whole-time worker on this subject but is merely one part of the various duties of the entomological staffs at Pusa and in the provinces. Cotton is not a regular field crop in the district around Pusa but a small area is maintained on the estate especially for the study of cotton pests and their parasites; this work has proceeded during the year and numerous observations have been made but nothing of striking interest has occurred. In Madras the Government Entomologist has continued the study of the strains of cotton resistant to the Stem Weevil (*Pempheres affinis*) and has confirmed the previous year's results on details of the life-history of the Pink Bollworm (*Platyedra gossypiella*), in connection with which the effects of the local Pest Act have also been studied. This Act, which applies to areas in which Cambodia cotton is grown, provides for the total clearance of all cotton plants from the fields for a definite period and, in those areas in which it has been applied stringently, very definitely beneficial results have been effected as regards diminution of loss due to bollworm. At Coimbatore also some study has been made of the bacterial infection of cotton bolls and the causes of bud and boll fall. In Burma observations on bollworms were made in the laboratory and in the field. In the Central Provinces the Pink Bollworm (*P. gossypiella*) has been found to occur commonly at Nagpur and will probably prove to be not an unimportant pest, though overlooked up to the present. In the United Provinces, the Government Entomologist carried out a considerable amount of research work on cotton-pests, principally the various bollworms (*Platyedra gossypiella, Earias fabia, E. insulana* and *E. cupreoviridis*) as being the most important pests from an economic view-point, and an extensive investigation of these insects was carried on throughout the whole year both in the field and laboratory and from biological and statistical standpoints. Particular attention was given to variation in the length of the life-cycle, rate of increase and hibernation and (in the case of *P. gossypiella*) to the long-cycle habit and dates of subsequent emergence of the moths. Considerable data were also collected on the percentage of infestation by bollworms and consequent loss of crop. This work must be

regarded as only preliminary to a fuller investigation, its main object being to indicate future lines of research. Experimental sowings were also made of seed treated by heat to kill the contained larvæ of the Pink Bollworm. In the Punjab, bollworms did not prove a serious pest during the year, the percentage of attack being only about five to seven per cent. Figures regarding the percentage of parasitization of the bollworms were collected from different parts of the Punjab, and at Hissar as many as fifty per cent. of the bollworms were found to be parasitized by *Microbracon lefroyi* and *Rhogas testaceus*.

Owing to the demand of the mills for long-staple cotton and the consequent extensive importation of American cotton, much of this coming direct to Bombay, from New Orleans and other American ports, there seems to be considerable danger of the importation into India of the destructive American Cotton Boll Weevil (*Anthonomus grandis*). Besides American cotton, a good deal of cotton is also being imported from Uganda, and of cotton seed into other ports of Western India. Should new pests be imported in this way, they may be expected to cause considerable loss in India, as Indian pests, such as the Pink Bollworm, have caused in Egypt, America and other cotton-growing parts of the world to which they have been carried with cotton from India. The situation in this respect is at present an anxious one and all these importations require to be watched carefully.

## V. Jute.

At present the world's supply of jute fibre is obtained almost entirely from North-East India, and the area sown under it from year to year is to a large extent governed by demand from abroad. It is, therefore, natural that the trade depression brought about by post-war conditions throughout the world should have affected the acreage under this crop which has further shrunk to 1,515,000 from 2,509,000* in the previous year. The estimated yield consequently fell from 5,885,000* bales of 400 lb. each to 3,982,000 bales, the outturn per acre

* Revised figures.

(1,051 lb.) being better by 113 lb. than in 1920-21 but lower by 145 lb. than the average of the preceding ten years. The value of raw and manufactured jute exported during the year was Rs. 44,04 lakhs as against Rs. 69,35 lakhs in 1920-21.

Two main species of jute are cultivated in India, *viz.*, *Corchorus capsularis* and *C. olitorius*, but it is from the former that the great bulk of the crop is derived. There are numerous varieties of both species and one of the most successful pieces of work of the BENGAL Agricultural Department has consisted in the isolation of superior yielding strains of both species.

The non-chlorotic *capsularis* races R 85 and D 154, isolated from the famous Kakya Bombai, so far remain the high water mark as regards yielding capacity, and this, together with the excellent quality of the seed produced under departmental auspices, has given it a wide popularity among cultivators. So much is this the case that Government seed is now sold at prices approaching three times those ruling for ordinary bazaar seed. Two new races, D 27, a pure line selection, and Dhal × Kg, a hybrid, tested this year on a large scale, proved as good yielders as the three established varieties. The *olitorius* Chinsura Green again showed itself to be in a class by itself.

The growing demand for seed of the new and improved varieties could not be met as only 39 tons were available. The reason for the deficiency was partly a poor crop in Assam and partly the competition of sugarcane in Bihar, the two provinces on which the Bengal Agricultural Department has to rely for growing seed of its selected strains.

Selection and cross-breeding work was continued, and there are at Dacca in the present season 559 single plant cultures. All selections are now made on the basis of absence of chlorosis as one characteristic, and the result has been seen in the extraordinary growths made even in an unfavourable season by non-chlorotic cultures. Seed of D 154 sown on high land as late as 9th June, 1922, after the monsoon had begun, has given as much as 1,600 lb. of fibre per acre in one case, while the best yields from chlorotic races were in the region of 640 lb. It is obvious that a non-chlorotic race can be sown on suitable land a month later, and it follows that it can be grown over a much

wider area than one affected with chlorosis. Thus the work on jute has succeeded in expanding the potential jute-growing tract beyond what was considered possible when the investigation was commenced.

Further work on the length of ultimate fibres has shown that it is a hereditary function, though subject to variation due to environmental action. Cross-fertilization between plants of great stature and others having long ultimate filaments has been made and the resultant types are being multiplied.

Rotational and manurial trials made during the year gave a further striking demonstration of the beneficial effect of lime, phosphate and potash on jute grown on the acid red soils of Eastern Bengal.

In ASSAM, the Bengal selection Kakya Bombai has definitely established its superiority over the local varieties. Two other Dacca strains, D 154 and Chinsura Green, have also been obtained to test them against Kakya Bombai. Experiments are in progress to ascertain whether jute and *sail* paddy can be grown with profit in the same year on the higher land in the Surma Valley.

In the season 1921, there were 97 acres under jute in the Ganjar tract of the UNITED PROVINCES where conditions similar to those existing over large areas of Bengal prevail. About 6,150 lb. of seed and 24,600 lb. of fibre were produced. A further development has taken place in the present season.

## VI. Other Fibres.

*Sida.* Excepting in Bengal and Bihar, under Mr. Finlow's supervision, the trials in India have not been very encouraging with this plant. The comparatively poor results are probably due to unfamiliarity with the method of cultivation. In Burma and the Malay Peninsula, more satisfactory results appear to have been obtained.

*Sisal.* This investigation commenced at Dacca with a very complete collection of agaves of various kinds from all over the world.

Strains of sisal hemp (*Agave rigida*) from various places have shown that the time between planting and "poling" varies greatly. For instance, some strains "poled" less than 5 years after planting, while one or two have already lasted eleven years. The significance of this is that the longer lived variety would be much cheaper to cultivate than the other because the expense of replanting would recur much less frequently. Similar variations have been noticed in *Agave vivipara* and in *Furcræa* spp. Bulbs of the improved strains are now available for distribution.

Some progress was made at Pusa in the breeding work on Roselle. A stock of seed of *Hibiscus cannabinus*, Type 3, is being maintained.

## VII. Indigo.

The area under this crop rose from 240,500* acres in 1920-21 to 316,600 acres in 1921-22 and the yield of dye from 41,200* cwt. to 60,900 cwt., showing a slightly more favourable season. The increase in area occurred chiefly in the Madras Presidency, where the industry is mainly in the hands of small holders and the dye manufactured is of an inferior quality. In Bihar, where a superior type of dye is manufactured in large factories, the acreage has steadily decreased to the pre-war level.

The Indigo Research Chemist, who has left Pusa on the close of his short term agreement, carried out trials during the year under review to ascertain the factors determining efficiency of extraction and purity of the resulting indigo. Taken together, the trials showed that the best practical results could be obtained by combining favourable fermentation (a high yielding organism and elimination of destructive forms) with suitable conditions of loading determined by the quality of the plant. The results, however, require confirmation.

## VIII. Tobacco.

The most important tobacco tracts in British India lie in the provinces of Madras, Bengal, Bihar, Bombay and Burma.

* Revised figures.

These produce a coarse article which to some extent meets the local taste, but in recent years the growing cigarette habit has created a strong demand for finer foreign grades which has only been steadied by heavy import duties. The home cigarette industry can thus be best supported by producing in India tobacco suitable for this purpose. The production of genuine Indian cigars can similarly be assisted by providing a better outer leaf or wrapper of finer tobacco.

The work on this crop at PUSA has resulted in a type (No. 28) which combines yield and quality and is suitable for cigarette making and general cultivation. It is gaining favour among cultivators in Bihar, Madras and Burma, and seed for over 60,000 acres was issued during the year. In the Kistna Delta, very good samples of leaf were obtained in spite of the unfavourable season.

In BENGAL, the Burirhat farm is devoted mainly to tobacco. Trials of Sumatra, American and Turkish varieties, and experiments on the improvement of local varieties by selection and on the manurial requirements of the crop are in progress. The reputation of Sumatra tobacco grown from the carefully selected seeds of the farm as a cigar *wrapper* has now been established in the market. A better *filler* than Sumatra is, however; wanted to establish cigar-making as a successful enterprise, and of the four new varieties tested during the year Manilla No. 2 seems to be the most promising. Among the indigenous varieties, Bhengi has proved to be the heaviest yielder and fetches the highest price from the Burmese dealers who make the well-known Burma cheroots out of this variety. The manurial experiments have established sann-hemp and farmyard manure as the best combination for the crop. This not only increases the yield but the green manure appears to have some deleterious effect on *Orobanche*, a root-parasite which causes great damage to the crop. In pot-cultures fish guano combined with lime has proved so successful that a trial will be made on a field scale this cold weather.

One of the Rangpur varieties—Motihari—when grown in ASSAM gave an average increased outturn of 342 lb. per acre over the local kinds.

A really systematic study with a view to the development and maintenance of the best and most suitable types of tobacco has been started on the Nadiad farm in BOMBAY.

A large cigarette factory, which suffered last year a loss of about seven lakhs of rupees from the activities of the Cheroot Beetle, was recommended from Pusa a method of fumigation of finished cigarettes with the result that no further complaints have been received.

## IX. Oil-seeds.

The area under the principal varieties of oil-seeds—linseed, rape, mustard, sesamum and groundnut—rose from 13,836,000* acres in 1920-21 to 15,700,000 acres in 1921-22, and the yield from 2,532,000* tons to 3,015,000 tons. The total quantity of oil-seeds exported during the year was 735,000 tons (one-fourth of the total production) valued at Rs. 17,46 lakhs as against 624,000 tons valued at Rs. 16,84 lakhs in the previous year, and that of oil-cakes 113,000 tons as against 95,000 tons in the preceding year.

While the area and yield show very little variation from the average of the quinquennium ending 1914-15, the exports now amount in quantity to only half of the pre-war average. The natural conclusion is that more oil-seeds are crushed locally than before and that larger amounts of oil-cakes are available both for feeding cattle and for manuring.

*Linseed.* The isolation and classification of the unit species which make up the linseed crop has been completed at Pusa. The types fall into two main classes, one suitable for the soils of the Peninsula, the other for the alluvium. A beginning has been made in testing the black soil types on the various farms in the Central Provinces. Among the 122 types isolated, no large seeded form with a root system suitable for the alluvium has been found. Breeding work has been started to create this and other desirable types.

*Safflower.* A collection of unit species of safflower made at Pusa has been handed over to the Bombay Agricultural Department for trial at Poona.

* Revised figures.

*Sesamum.* In Burma, 185 strains isolated in 1920 were sown in pure line cultures, but owing to the failure of the early rains seed of only 114 was, with difficulty, saved. In the United Provinces oil-content is being arrived at.

*Castor.* The two types selected in Bihar for their oil-content when grown on a field scale maintained their qualities. Experiments have been laid down to find if differences in manuring and spacing between plants had any influence on oil-content. A red-stem and a green-stem variety have been selected at Cawnpore from a collection of castors from Bundelkhand.

*Groundnut.* Owing to the great economic value of groundnuts and the fact that they grow well on light land, selection work and varietal tests on the crop are in progress in most of the provinces.

Experiments at Mahalaing in BURMA with two spreading varieties, Burmese and Pondicherry, and two erect ones, Spanish and Small Japanese, indicate that the yields of the latter are probably lower than those of the former. The erect types, however, obtained a better price and cost less in harvesting owing to the great ease with which plants can be pulled. A beginning has been made in the selection of groundnuts for oil-content. Two new varieties, Upright American and African, received during the year, are being multiplied at Tatkon.

Several single plant selections of groundnut made last year at Palur in MADRAS were grown separately, but their characters have still to be studied. Variety tests are also made at Naduvirapattu.

Small Japanese groundnuts gave a remarkably big yield in the well-drained sandy loam of the Chhindwara farm in the CENTRAL PROVINCES. Its cultivation has been taken up in the adjoining villages where its outturn is worth at least six times as much as that of the millets usually grown in this tract.

In the trials made at the Ranchi farm in BIHAR, Type 17 yielded better than No. 45 and Pondicherry and about the same as No. 11. The former is being distributed and further selections are being made.

In BENGAL, the soil sets so hard after the rains are over that the cost of harvesting this crop becomes prohibitive. It is, therefore, proposed to introduce early ripening varieties.

*Coconuts.* In MADRAS, the study of the coconut palm was continued on four stations. The methods of cultivation adopted at Kasargod have nearly doubled the yield of nuts during the last four years. Excellent results have also been obtained at the new stations planted in 1919 and 1920 by adopting the improved method which consists mainly in surface planting instead of the usual practice of planting in deep pits and in the maintenance of a soil mulch over the whole area. Sufficient data have now been collected of the yielding capacities of each tree at Kasargod and a series of experiments has been laid down to test the manurial requirements of the palm.

An improvement in the local methods of tapping the trees and manufacture of *jaggery* has also been taken in hand. Suitable simple sand filters have been devised for removing impurities from the juice, and a method has been worked out for removing the lime (with which the collecting vessels are treated to prevent fermentation) by the addition of a small quantity of alum. As the result of this, *jaggery* of excellent colour and satisfactory keeping qualities can readily be prepared.

In BURMA, the dwarf coconuts from the Federated Malay States, which are reputed to bear in the fourth year, are reported to be doing well at Hmawbi. A small number of these have been sold to growers to observe their behaviour under different climatic and soil conditions.

Varieties of coconuts from Travancore have been planted on drained paddy land on the Cuttack farm in ORISSA for preliminary comparison with the local types.

In TRAVANCORE, spacing and manurial experiments are in progress. The campaign against *Nephantis serinopa*, a serious pest of coconuts, was carried on vigorously, and ryots were induced to cut off and burn the affected leaves.

The practice of curing the stem-bleeding disease of the coconut palm by operation was more largely resorted to in Madras, and trees attacked with bud-rot were destroyed.

## X. Tea.

The area under tea showed a slight rise from 704,100* acres of the preceding year to 709,100 acres in the year under review. The total estimated yield was, however, lower, being 274,264,000 lb. against 345,205,000* lb. in 1920-21. The average production in the whole of India was 438 lb. per acre plucked as against 534 lb. in the previous year.

It was realized early in 1921 that in order to meet the lessened demand, due both to the absence of Russian buyers from the market and to the stocks of old tea, a short crop was of great importance. By general agreement fine plucking was resorted to. This resulted in making the general range of qualities exceptionally high and creating a strong demand at steadily rising prices. The prospects of the current year appear to be more favourable.

The Scientific Department of the Indian Tea Association continued its investigation of problems relating to the crop. During the year a considerable amount of work has been done in connection with tea manufacture. An investigation is in progress dealing with the chemistry of the tea leaf and the changes that are brought about by manufacture. A study of the various micro-organisms present during the manufacturing process is also being made.

In Southern India the crop continues to be dealt with by the agricultural staff of the planting districts. Particular attention was paid to improved methods of pruning and manuring.

## XI. Coffee.

The coffee industry of the country is practically confined to Southern India, comprising the Madras Presidency, Coorg, and the States of Mysore, Travancore and Cochin. The total reported area under the crop was 127,273 acres—an increase of one per cent. over that of the preceding year. The total production of cured coffee during the year was 20,645,700 lb. as against 22,486,700 lb. in 1920-21. The crop was much

* Revised figures.

below the average, but this was compensated by good prices for all grades.

Jackson's coffee hybrid and Kent's Arabica, a selected strain, continued to be popular, and a considerable quantity of both was exported to the Kenya Colony during the year. The hybrid, planted on an experimental estate scale, continues to give good crops and outturn and the produce is gaining favour on the London market, while Kent's Arabica has proved to be a vigorous disease-resistant strain and is growing and cropping well on land where the ordinary strains fail.

A new series of experiments is being laid down to test different strengths of spraying mixtures and different spreaders and adhesives with a view to see if the method of spraying as a preventive of leaf disease and other fungi can be cheapened.

In Mysore, the coffee borer (*Xylotrechus quadripes*) gave considerable trouble throughout the year. The scrubbing of stems at the right season has, however, become a routine with many coffee planters and undoubtedly leads to a marked decrease in the damage done to the crop.

## XII. Rubber.

Rubber is grown mainly in Southern India, Burma and Assam. In the year under review the area under it was 196,990 acres as against 204,663 acres in the preceding year, while the total production of raw rubber was 9,056,400 lb. as against 13,788,900 lb. in the corresponding periods. The state of the rubber market throughout the year was one of steady depression. The low prices and the slump in the market led to a restriction in output especially in Southern India where large areas were thrown out of tapping altogether. Planters have been advised to put such areas under a cover crop of *Tephrosia candida* which not only preserves the soil from erosion, but saves the weeding costs and adds fertility to the soil. A valuable series of experiments has been started by the Rubber Mycologist, Madras, who has also taken up the special study of diseases such as Brown Bast, Patch Canker and *Phytophthora*.

## XIII. Fruit.

In India with its large vegetarian population not only is there a great demand for good varieties of fruit, but there exist vast tracts of country where the conditions are suitable for the propagation of fruit trees. The indigenous methods of fruit culture, however, leave much to be desired. Unfortunately trained horticulturists are few and improvement is in consequence slow. In several of the provinces, however, earnest efforts have been made to establish better varieties of fruits, and to improve the methods of cultivation, packing, etc. The results have on the whole been satisfactory. For example, the work done at Quetta and Tarnab has resulted in the establishment of a number of really good gardens, laid out and worked on up-to-date lines, in Baluchistan and the North-West Frontier Province. A more thorough investigation of the economics of fruit-growing is, however, necessary, and it is to be hoped that a special horticultural section will ere long be created in all Provincial Departments of Agriculture.

In the North-West Frontier Province much good work has been done on fruit culture. The foreign varieties of peach and plum propagated at the Tarnab farm have been found so superior that no variety known to the local fruit growers upto 1917 is now considered worthy of a place in a commercial orchard. These varieties not only yield more but are less subject to disease and serve to prolong the season by no less than two months. A French variety of apricot budded on the peach stock has proved very prolific and of excellent quality, and experiments with the European melon indicate that it will be a profitable fruit to grow. The olive trees on the farm are bearing well, but before the propagation of the fruit on a large scale is undertaken it is proposed to determine the quality and the quantity of oil in the best varieties. None of the numerous varieties of orange on trial have proved better than the Lahore Malta; even the noted Washington Navel is disappointing. The Malta orange budded on the sweet lime grows, however, feebly, and it is proposed to grow it from seed. The

seedling orange does not fruit so early as the budded one, but it lives and bears fruit longer.

In BOMBAY, high-yielding grapevines are being used as stocks and propagated to see if the low-yielding types can be made to bear better than at present. Selection work is now extended to guavas, oranges and mangoes. The variation in yield of the same variety in the same orchard planted at the same time and cultivated and treated as nearly equal as possible, and the common occurrence of the rough and smooth or sour and sweet oranges on the same branch have led to an investigation into the problem of selection of stock and scion in citrus propagation. Experiments are also in progress to preserve pomegranate and lemon juice in good condition.

The pomological station opened in 1920 at Coonoor in MADRAS has now been fully planted up with all kinds of fruit trees, and at the close of the year more than 1,600 grafted plants were ready for sale. Cape gooseberries has been found to be a most profitable crop, and a large quantity of seed has been offered to the public. The cultivation of pineapples at Taliparamba promises to provide a profitable industry for the West Coast. They thrive exceedingly well on the ordinary hill land and very fine fruits of varieties such as Kew and Cayenne, some of them weighing over 10 lb., have been produced.

The Arabian date-plantation in the PUNJAB continues to prosper. All the trees have not yet come to full bearing age, but the plantation has reached a stage when the inter-crops should pay for its upkeep.

The orange trees on the Nagpur farm in the CENTRAL PROVINCES having now reached the fruiting stage, a series of analyses are being made to determine the effect of the stock on the nature of the fruit produced.

The fruit-growing experiments at Shillong are being continued by Mr. Holder to whom the orchard has been leased by Government for ten years. Varieties of apples and pears successfully tried on the station are distributed by the ASSAM Agricultural Department for propagation.

Demonstrations of methods of spraying in orchards against fungal diseases of the apple, pear, peach, etc., were continued by the Mycological Section at Pusa, and a new sprayer was tried on a commercial orchard, effecting considerable saving in time, labour and material. Spraying operations were successfully carried out in the Punjab against insect pests of citrus and mango.

## XIV. Fodder Crops and Grasses.

Although the improvement in grain yields has been and will continue to be accompanied by an increase in the straw which forms the bulk of the cattle food in India, the rapid extension of arable cultivation, coupled with the stricter conserving of jungles as reserves, has, on the other hand, tended to restrict grazing areas, and, in consequence, the green food which is an essential addition to the diet of animals which subsist for the most part on dry stalks and leaves. The question of green crops for cattle is therefore more important than ever, and the trials of various exotic legumes and grasses mentioned below in different parts of India are thus of much greater importance than a casual acquaintance with the subject might indicate.

At PUSA, the method of cultivating lucerne on flat beds, two feet wide with irrigation furrows one foot wide between the beds, enables the crop to be carried through the hot weather and rains, is economical of water, and gives good outturns. So far this crop has not been induced to seed freely at Pusa, and experiments have been put in hand with the object of discovering the factors on which seed formation really depends.

Large scale trials of berseem (Egyptian clover) have proved very successful at Pusa and Peshawar. This clover is famed in Egypt as a fodder and a soil renovater and the experience in Sind, Bihar and the North-West Frontier Province fully bears this out. Introduced into India some years ago by Mr. G. S. Henderson, it has proved a far better fodder for the North-West Frontier Province than shaftal and bids fair to oust the latter as a green fodder crop. It is now grown at Pusa

METHOD OF TETHERING CATTLE ADOPTED AT PUSA IN GRAZING BERSEEM ON NEW RECLAIMED FLOODED LAND.

PLATE III.

as a winter grazing on flooded land (Plate III) and is followed in the same year by a crop of early maize which requires no manure after berseem, thus establishing what is practically a self-supporting rotation, so far as manure is concerned, in poor land which would otherwise have required bunding against flood and a liberal manuring to produce the same outturns.

Trials in BURMA on the Mandalay farm have resulted in the discovery that berseem can be grown successfully by sowing the seed in the mud of the paddy fields before the crop is harvested and by subsequent irrigations.

At Mandalay, the saccoline introduced from New South Wales is likely to prove of great value. It withstands drought well and matures almost a month earlier than local millet.

On the Coimbatore farm in MADRAS, elephant grass has proved a valuable addition to the fodder crops. During the year under review, an area of 12 cents gave in five cuttings a total weight of 20,500 lb. of green fodder, *i.e.*, double the yield of Guinea-grass.

In ASSAM, comparative tests between Sudan-grass and Guinea-grass have resulted in favour of the latter.

In the UNITED PROVINCES, sunflower when grown during the hot weather has been found capable, with irrigation, of giving a fair yield of green fodder which when mixed with dry sorghum or *bhusa* was relished by the stock. Its possibilities as a *kharif* crop are now being investigated.

## XV. Juar (Sorghum).

*Juar* occupies a third place among the cultivated crops in acreage, covering an area of 28 million acres. Its grain forms the chief article of diet of a large section of the population in Bombay, Madras and the Central Provinces, while its stems form the main item in the diet of the cattle.

In BOMBAY, the application of strict plant selection methods to this crop promises to lead to considerable improvement in yield. Two decided successes in improved cultural methods are

also reported. Repeated shallow hoeings to the land during droughts in the Sholapur District resulted in a crop about 25 per cent. higher than that of surrounding cultivators, while an increase in yield of 55 to 60 per cent. has been obtained for three successive years by the adoption of ridge cultivation in black soils of Gujarat suffering from water-logging.

The newly appointed " Millets " Specialist in Madras has started a detailed examination of the various types of sorghum grown in the presidency. In the meantime, the selections made on the Hagari and Nandyal farms are being distributed.

Of the numerous varieties of *juar* tested up-to-date in the Central Provinces, the Saoner, Ramkel, Chapti and Lamkansi varieties continue to give large yields. Seed for distribution is being multiplied both on Government and private seed farms.

Several large scale experiments undertaken in Bombay indicate that the ravages of *Amsacta moorei*, the Katra caterpillar which does enormous damage to all cereal crops at the beginning of the rains, can be checked to a large extent by means of a dusting with a mixture of Paris green and lime.

## XVI. Ragi (Eleusine coracana).

The work on the improvement of *ragi*, which is the most important crop in Mysore, was continued on the lines of individual plant selection. During the year some half dozen of the improved strains showed increased yields of the value of Rs. 25—35 over local Hullubile. One of them, H 43, gave the high yield of 2,040 lb., and it seems highly probable that some of these new varieties will displace the now popular H 22 which has already extended over 10,000 acres. Difficulties connected with cross-pollination having been overcome by the discovery of a simple method in technique, hybridization work on this crop has been commenced this season.

The very favourable results obtained by rotating *ragi* with groundnut deserve special mention. Some plots which carried *ragi* after groundnut gave a 50 per cent. greater yield than neighbouring fields where *ragi* was followed by the same crop.

## XVII. Potatoes.

The potato crop is steadily increasing in popularity in India. It is of relatively recent introduction into this country, but its value as a food crop is now thoroughly appreciated, and the area is being extended year by year in response to the demand for the produce. This is satisfactory so far as it goes, but there are problems more especially connected with the supply of seed and the control of disease which will have to be solved, before any rapid spread is possible.

The acclimatizing, testing and distribution of potato seeds continue to be the main feature of the programme of the Upper Shillong farm in ASSAM. This year 20 varieties were under test which include six new ones imported from Scotland early in 1921. King of Potatoes, British Queen, Up-to-date and Imperator again gave the heaviest yields and are being mainly grown for seed.

The demand for improved strains is increasing rapidly both in the plains and in the Khasi Hills where the old varieties are being rapidly displaced. To assist propagation, seed potatoes are distributed to Khasi cultivators on condition that they return one and a half times as much as the seed supplied. 20·8 tons of seed was issued on this system during the year.

A yield of 6,150 lb. of potatoes per acre in the monsoon at Neterhat in BIHAR, coupled with the excellent market in October, holds out hopes of profitable cultivation when sufficient manure can be obtained.

With a view to the introduction of better varieties in BENGAL a proposal is on foot to establish a small potato farm near Darjeeling where the crop can be properly grown during the rainy season. Some of the seedlings raised at Kalimpong show signs of great promise.

Twenty-one seedling varieties are also under trial in the PUNJAB, and the Economic Botanist has been able to carry out crossing successfully. Scotch potatoes introduced in the Simla hills occupied over 400 acres and beat the *desi* varieties to the tune of 4,000 lb. per acre.

In MADRAS, 32 varieties, including 25 from England, five from Australia and two different lots of seedlings raised on the

Nanjanad farm, were tested. Three Australian varieties proved to be the heaviest croppers, but they are not likely to prove of much value as the individual potatoes are too large and the eyes are too deep to suit the Indian market. Experiments with different manures show that fish guano is an excellent substitute for cattle manure.

A beetle of the genus *Gonocephalum*, which did considerable damage to the potato crop in Madras, was kept in check by placing poison baits. Proper earthing up is indicated to be the remedy against the activities of the caterpillar of the potato moth, as only tubers near the surface of the soil are found to be affected.

All difficulties in dealing with the mite which causes the *tambera* disease in BOMBAY having been overcome, the growing of potatoes in the *kharif* season on a much larger scale has become possible. Detailed investigations on the *Fusarium* blights of potatoes made by Dr. Mann indicate the importance of developing strains of pedigree *Fusarium*-free seed, and it is on these lines that further work will be carried on.

## XVIII. Beans and Pulses.

In BURMA, the area under Pebyugale (*Phaseolus lunatus*) is gradually decreasing on account of the prussic acid scare. Attempts to find an acid-free strain have hitherto failed, but it may be possible to obtain plants which will contain such small amounts of acid as to satisfy any ordinary test. Several varieties of Japanese beans and Shan beans (*Phaseolus vulgaris*) are also being tried at Mandalay to find a suitable substitute, but the task is one of considerable difficulty. The importance of *P. lunatus* is due to its being a cold weather crop and a crop which gives fair yields on the upland " ya " and with the very small rainfall of the dry zone, while *P. vulgaris* varieties in general need a cooler climate and a moister atmosphere. It may, therefore, pay farmers better to grow Pebyugale, even if the price is low, than other prussic acid-free kinds which yield poorly.

Three varieties of soybeans selected in Burma are being multiplied.

Soybeans grown at Ranchi in Bihar and Orissa gave yields up to 780 lb. per acre. Endeavours will be made to produce a heavy yielding seed of high oil-content, using the crop entirely as cattle food until a trade in seeds can be established.

The cultivation of *Cajanus indicus* is rapidly extending in Burma, and to meet the demand for an early maturing red-seeded variety, several types imported from India are being employed at Mandalay.

The cultivation of gram on flooded land in the Pegu District is being encouraged by the distribution of free seed. At Padu, Karachi gram maintained its reputation for freedom from wilt, and seed of this variety was eagerly sought for by cultivators. Various other varieties from India are also being tested to keep in reserve as many disease-resisting types as possible.

In Bihar, Sabour Type No. 2 is proving itself better suited to local conditions than Patna gram which has hitherto been recommended by the department, while some of the strains selected at Lyallpur have been found to yield more than the local grams of the Punjab when grown on a field scale. Pusa types of gram are making good progress in the localities in which they have been introduced.

## CHAPTER III.

## RESEARCH AND INVESTIGATION.

Space does not permit of an adequate review of the large amount of research and investigation undertaken by the various Departments of Agriculture in India. Most of the investigations are still in progress and have not yet reached the stage at which the results achieved are of much interest to the general public. Readers interested in any particular branch of research are referred to the Scientific Reports of the Pusa Agricultural Research Institute and to those of the provincial research officers which are published separately.

### I. Soils.

***Survey of soils.*** Soil surveys are now in progress in Madras, Bihar and Bengal and will when complete yield valuable information for workers on soil problems all over India.

In MADRAS, the examination of the soils of the Godavari delta and the Periyar area has been completed. Both these surveys indicate a deficiency in phosphates and nitrogen which is marked in the case of Periyar but much less in the Godavari than in other deltaic areas.

In BIHAR AND ORISSA, the continuation of the soil survey in the South Ganges *diara* tract of the Bhagalpur District showed the soils, unlike those further south, deficient neither in phosphoric acid nor nitrogen.

Satisfactory progress was made in BENGAL with the provincial soil survey, a large number of soil samples from Government farms and demonstration centres having been analysed. Work in continuation of the soil survey of the tea districts was done by the scientific staff of the Tea Association and a note has been issued dealing with some of the soils of the Bengal Dooars.

The investigation into the patches of good and bad cropping in certain of the fields of the Experiment Area at PUSA has been continued, and it is becoming evident that there is some

correlation between the character of the cropping and the character of the soil found in the various subsoil layers. Particular attention is, therefore, being paid to determining the relative amounts of colloids in the layers.

***Soil gases.*** Further periodical determinations of the carbon dioxide content of three plots in the Botanical Area at Pusa confirmed the previously arrived at results that the soil atmosphere of the grassed plot is uniformly richer in $CO_2$ than that of either the trenched or cultivated plot, and that this difference is most marked during the monsoon months. The latter phenomenon is associated with fairly high temperatures and heavy rainfall, and the conclusion is drawn that it is due to the decomposition of the organic detritus introduced into the soil from the roots of the grass. It has also been found that during the dry season the moisture content of the grassed plot becomes as low as 1 per cent. as compared with 1·3 per cent. and 5·5 per cent. of the trenched and cultivated plots respectively.

***Soil moisture.*** In the Bombay Deccan, there are large tracts where rainfall is precarious and irregular and where the amount of irrigation must always be small. The conservation of soil moisture, especially for the *rabi* season, is consequently the predominant factor in crop production. Investigations have, therefore, been put in hand to determine the physical properties of these soils and to investigate means to increase their water-holding capacity.

***Reclamation of saline lands.*** The experimental work on the reclamation of the saline soils of the Montgomery District in the Punjab has now taken a definite turn in three main directions: (1) scraping off the superficial layer of salt and subsequent cultivation; (2) heavy irrigation, followed by further flooding up to the time for cultivation; (3) scraping the land and leaving it fallow in order to note whether any further rise of salt occurs. So far scraping appears to have had a better result judged by the subsequent yield than mere flooding, and no appreciable rise of salt has been noted on the scraped and unirrigated land after the lapse of a year.

On the Narwala farm, in the same province, salinity appears to be confined to the upper six feet and the effect of light irrigation to move the salt content only a few inches. It is proposed to apply several heavy irrigations at intervals of 10 days to ascertain if the salt can be washed out more completely.

The treatment of *bara* soil (*i.e.*, soil infected with sodium carbonate) with gypsum and castor cake continues to give results, the crop produced being far superior to that on untreated land. The best crop hitherto obtained is, however, not such as would be considered an economic one on ordinary soil.

***Movements of nitrates.*** A study of the movements of nitrates in the soil and subsoil with a view to the correlation with seasonal and cropping variations has been begun at Pusa. Observations made during last year show that the distribution of nitrates through the subsoil is determined by climatic factors and by the physical characters of the subsoil layers, and that the growth of the crop is in turn controlled to a considerable extent by this distribution. The extent to which these controlling factors can be modified by agricultural operations is a subject for future investigation.

Similar observations have also been made at Cawnpore in the United Provinces. From the evidence collected, the conclusion is arrived at that, under the ordinary system of cultivation in Upper India, conditions are favourable for rapid nitrate accumulation at two seasons: (1) immediately after the first rains of the south-west monsoon in June or July, and (2) at the beginning of the cold weather season in October. These months coincide with the beginning of the two agricultural seasons, and occur just before the sowing of the summer (*kharif*) crop and the cold weather (*rabi*) crop.

An investigation was made by the Scientific Department of the Indian Tea Association to determine the effect of moisture conditions upon the nitrate formation in soils of North-East India. It was found that in soils having water content less than optimum, ammonia tended to accumulate and the formation of nitrate was slow, whereas at a higher water concentration the amount of ammonia was low but there was a corresponding rise in nitrates while with much higher water content

ammonia was formed and gradually disappeared but did not remain as nitrate or nitrite.

## II. Nitrogen Fixation.

In the Punjab, a fixation of nitrogen amounting to an increase of 30 per cent. of the total amount in the soil has been observed to be common, and in one instance it reached 75 per cent. without the addition of any carbohydrate. These figures represent enormous amounts of nitrogen which would take impossible sums of money to purchase in the form of manures, and show not only the vital part played by soil bacteria in the agriculture of North-West India but the great possibilities which may follow on an investigation into the controlling factors.

The amount of nitrogen fixed by the leguminous green-manuring plant *dhaincha* (*Sesbania aculeata*), when grown in nitrogen-free sand, is being studied in Bihar. It was estimated last year that 50—60 days old plants gave on the average, under ideal conditions of aeration, some 2·62 grains of nitrogen and 0·074 lb. of green matter. The figures give some indication of what can be expected by the use of phosphates and green manure in sandy soils, provided potash and lime are also present.

Work was done at Pusa on symbiosis between algæ and nitrogen-fixing bacteria and on the value of plant residues as nutrients for nitrogen-fixing bacteria. The abundant algal growth that took place in suitable media inoculated with soil and exposed to diffuse day-light was accompanied by a much higher fixation of nitrogen than in duplicate sets of medium kept in the dark where algal growth was not visible. Fermented green manure was found to contain a readily available supply of foodstuff for the growth of the nitrogen-fixing organism—azotobacter. This is an important factor to be considered when comparing the relative values of fermented and unfermented green manures.

## III. Manures and Fertilizers.

Further observations on the losses of nitrogen from cattle dung and urine made at Pusa showed that greater losses occurred

when these were stored in mixture than when stored separately. While the urine lost most of its nitrogen when kept under aerobic conditions, there was little loss even after many months' storage under anaerobic conditions. A thin layer of oil on the surface of urine provided the necessary anaerobic conditions.

In Madras, experiments on a large scale are being made to ascertain whether it is possible to devise a method of storage which is not costly and which will reduce the loss of plant food to a minimum.

The recent announcement that artificial farmyard manure has been successfully prepared in England from straw has evoked considerable interest, and experiments have been started both in Madras and the Central Provinces to ascertain what are its possibilities in India. An "artificial farmyard manure" made by fermenting green sann-hemp has been in use at Pusa for some years.

The possibility of rendering the at present unavailable nitrogen of *mahua* (*B. latifolia*) cake and phosphate of rock phosphate of service to crops is the subject of another investigation at Pusa. Detailed experiments carried out during the year have definitely shown that when the cake is composted with nodule phosphate and sulphur there is not only increased nitrification (40 per cent.) but as much as 4·32 per cent. of citrate-soluble phosphate is obtained from the nodule. In view of the importance of dispensing with the use of sulphuric acid as a solvent, the results obtained by composting are of considerable interest. In Madras, it has been ascertained that mineral phosphate, ground as fine as possible, is a suitable phosphatic manure for paddy lands when applied along with decomposing organic manures.

The permanent manurial and rotational experiments at Pusa are being continued and expanded in view of the experience gained. The chief result of importance during the year has been the re-establishment, by a single ploughing in of a green manure, of the fertility of a series of plots "phosphated" five years ago which had to all appearance, through repeated cropping, dropped to a lower scale of fertility. The non-phosphated check plots showed no such results. The phenomenon,

in addition to being one of considerable scientific interest, is of the greatest practical importance to agriculturists, indicating great possibilities of saving in the quantity of manure applied.

In BIHAR AND ORISSA, the field experiments initiated with a view to test the effect of phosphates, when applied with green manure (*Sesbania*), in paddy, in parts of South Bhagalpur where the soil is poor in phosphates, again gave remarkable results. Not only was the grain yield actually doubled, but there were also very large increases in straw.

The application of bone-meal and lime on the laterite soil of the Dacca farm has resulted in an increased yield of paddy crops accompanied by early ripening and an apparent drought-resistant effect. Research work has been taken up in the laboratory to investigate this phenomenon which is one of very great importance.

The liming and manuring experiments at Jorhat in Assam laid down in 1909 were continued. The results hitherto obtained indicate that with the use of lime or ashes, in addition to cow dung, not only is a much greater variety of cropping open to the ryot in Assam Valley, but the outturns of most crops can be greatly increased. Ordinary fertilizers, excepting phosphates, have no effect in the absence of lime, while sulphate of ammonia acts adversely without the addition of lime, and when repeated tends to increase the toxicity of the soil.

Preliminary experiments made at Coimbatore with calcium cyanamide have confirmed the results obtained in Europe that if the manure is thoroughly incorporated in the soil no harmful results are to be feared, and that the process of decomposition takes place in two stages, firstly, the chemical change converting the cyanamide to urea, and, secondly, the further conversion of urea by bio-chemical agency into ammonia and nitrates. A considerable number of field trials with this manure are being conducted this year on specially selected land.

Work carried out at Tocklai by the scientific branch of the Indian Tea Association to ascertain the difference in behaviour of potash manure added to various types of soil revealed very great differences in the growing tea bushes. In some cases immediate effect was noticed, while in others it was either

transient or non-existent. A study of the removal of potash from its salt solutions when added to soils was made, and a note on the subject was issued.

Considerable amount of work has been done in the Central Provinces on the nitrifiability of various oil-cakes in typical soils of the province. The results indicate that, given suitable conditions regarding moisture, castor, *karanja* (*Pongamia glabra*), sarson and other oil-cakes undergo decomposition within a period of eight weeks, and a high proportion of the nitrogen in them is brought into a form which plants can use.

## IV. Sugarcane.

Experiments on the windrowing of cane under Pusa conditions were continued. During the previous season the windrowed canes were exposed to practically no rain and were found to be in good condition one month later. By way of contrast, the windrowed canes during the season under review were subjected to heavy rainfall and deterioration of the cane was definitely and immediately established. It, therefore, appears that the length of time windrowed canes can be stored is determined by the climatic conditions.

An investigation into methods of testing the ripeness of sugarcane at Coimbatore indicates that the cane ripens joint by joint and that the most suitable time for cutting is when both the top and bottom joints show refractive indices the ratio of which is close to unity. It has also been found that the co-efficient of purity is not a reliable criterion upon which to judge the ripeness of cane. Work on similar lines at Jorhat goes to show that by the time the figures for purity co-efficient of juice of the bottom and top thirds of the cane stem approach to within two or three of each other, the cane is fully ready to commence milling. Mr. Meggitt has further ascertained that the quality of juice continues to improve for some four months after free early flowering and that the juice expression does not fall off to any appreciable extent.

Experiments have been started at Dacca with a view to finding out the cause of the high glucose content of canes grown on red laterite soils and whether this may be reduced by irrigation at the proper time.

## V. Preparation of Malt from Sorghum.

Work was continued at Coimbatore with sorghum in order to ascertain the conditions of malting leading to a malt capable of giving a high extract and hence suitable for brewing. There is some evidence that the high fat content in the sorghum grain has a detrimental effect on the resulting malt.

## VI. Animal Nutrition.

A post of a Physiological Chemist has been created during the year at Pusa to investigate the problems connected with animal nutrition. The main line of work in hand is the digestibility of the more common Indian fodders. A beginning has been made with rice straw, one of the most important fodders from the point of view of its distribution in India.

## VII. Lathyrism.

A promising start has been made at Pusa with the botanical work in connection with a detailed investigation, under the auspices of the Indian Research Fund Association, of that form of paralysis commonly known as lathyrism—supposed to be due to the long continued consumption of the seed of *khesari* (*Lathyrus sativus*). Various unit species isolated during the year, when analysed for alkaloid content, gave negative results, but the seed of a leguminous weed (*Vicia sativa*), which occurred in all samples of *khesari* obtained from localities where lathyrism is common, has been found to contain alkaloids. It is, therefore, proposed to make an intensive study of the various leguminous weeds met with in *khesari*. Storage experiments are also in progress with the view of discovering whether any alkaloids are developed by varying the conditions under which the seed is kept.

## VIII. Diseases of Crops.

The practical methods adopted for combating the ravages of diseases attacking the more important crops have been indicated in the previous chapter. It is proposed to deal here with only such investigations as have not reached this stage.

At PUSA appreciable progress has been made with the investigations into the disease of paddy caused by *Piricularia* which when in epidemic form is responsible for heavy losses. Infection experiments and the available meteorological records indicate that highly moisture-charged air and a definite temperature are the limiting factors most concerned in deciding whether the disease is to be absent or cause slight or great loss. Species of *Piricularia* similar to that on the rice plant have been found on crops other than paddy, but it is yet undecided whether they are physiological strains of one fungus or four different species.

Two other diseases of paddy are also under investigation at Pusa. One of them is caused by a sclerotial fungus which has not at present been identified. The symptoms of the disease and the morphology of the parasite closely resemble those of a disease of sugarcane which has been described in Java under the name Djamoer Oepas and has since been collected in India. Work is in progress to determine whether the causal fungus of the disease on paddy is identical with that on sugarcane. The other disease of paddy is possibly caused by a species of *Cephalosporium*. It seems not improbable that soil conditions may be the predominant factor in determining the incidence of this fungus as a parasite.

Cross-inoculations with *Helminthosporium* on rice, barley, wheat and sugarcane were repeated and the previous year's results were confirmed that these four species are closely allied and that they readily infect each other's hosts. The effect of the formalin and the hot-water treatments against this disease was tried on barley and oats at the time of sowing but the results were inconclusive.

Preliminary experiments have shown that the smut of *bajra* (*Pennisetum typhoideum*) is amenable to treatment, and further work on a field scale is in progress.

The cause of the reported immunity of thick varieties of sugarcane to this disease is also being investigated. It has been found that the varieties under test are susceptible to artificial infection although in nature they are as a rule free from smut.

The study of the fungus which causes a stem-rot of jute is being continued both at Pusa and Dacca. The disease is most severe where there is a deficiency of potash in the soil, and applications of sodium sulphate have been found to have had considerable influence in reducing the incidence of the parasite.

In MADRAS, besides work on the *Piricularia* and *Helminthosporium* diseases of paddy on similar lines as at Pusa, a disease which causes the shedding of leaves of sorghum is being studied. Field experiments have also been laid down to determine the causes of cotton wilt and how it spreads.

Storage rot of the potato, cotton wilt, and leaf spot and blight of onion are the principal subjects of investigation in BOMBAY. No treatment of potato tubers with fungicides is effective in keeping out or destroying the rot fungi, and the solution of the problem has probably to be sought in reduction of the temperature of storage below 85°F.

The newly appointed Mycologist in the CENTRAL PROVINCES has completed a preliminary survey of the fungus diseases of the most important crops of the province. Two of the main lines under investigation are the wilt on cotton and *Cajanus indicus*.

The storage rot of potatoes is under investigation by the Plant Pathologist in the UNITED PROVINCES. Attempts are being made to discover the various agents responsible for the rot, and the value of different common methods of storage is being ascertained. The wilt of safflower, the rust of linseed and collar rot of sesamum are other diseases engaging attention in this province.

Smut on *ragi* (*E. coracana*) called for serious notice in MYSORE during the year for the first time. Preliminary experiments seem to make it doubtful if this disease can be combated by methods which have been so successful with sorghum smut, and a detailed investigation has been put in hand. Attempts to discover and isolate the cause of sandal spike have not yet been successful, but the first direct and conclusive evidence that the disease is carried from tree to tree through root connections was obtained during the year.

## IX. Insect Pests.

The measures adopted against important pests of rice, sugarcane, cotton and tobacco have been referred to elsewhere and need no recapitulation. A large amount of useful observations relating to the life-histories and behaviours of other insects known to affect crops and also of their parasites have been made both at Pusa and by provincial-workers. Some of the most important of these are :—

At PUSA, the investigation on borers in sugarcane and other gramineous plants and on the relative immunity of varieties of cotton to bollworm attack was continued on the lines stated in previous reports.

Life-histories of various new insects were studied, and steady progress was made in addition to, and arrangement and identification of, the collection of specimens which forms a key to the whole of the information regarding Indian entomology. An Aphidid which attacked peach trees deserves special mention. The trees observed were quite healthy and the fruit within about three months of ripening when the leaves and shoots were badly attacked, with the result that the fruit wholly failed to ripen, some of it dropping off and some remaining on the tree for about six weeks after its normal date, when it rotted, still unripe, in the rain. The work under pathological entomology was continued mainly with reference to Culicidæ, *Ochromyia*, Mallophaga and Anoplura.

Investigations into the life-history and control of *Siga* (*Schœnobius*) *incertellus*, the paddy stem borer, were carried out in MADRAS. The results show that the pest can, to a great extent, be controlled, although not completely, by the examination of the seedlings removed from the seed-beds and the destruction of those which are attacked.

In addition to work on cotton and fruit pests, investigations into methods of protecting stored grain from weevil attack are in progress in the PUNJAB. About 60 experiments were performed during the year, and in all completely air-tight vessels the larvæ of the *khapra* beetle died within a few days. Even badly infested wheat when kept under air-tight conditions

improved, in so far that all the stages of insects attacking it were killed. All attempts to devise methods of storage employable under ordinary conditions by cultivators have, however, so far been unsuccessful.

In BIHAR AND ORISSA, the work on the braconid parasite of *Agrotis ypsilon* was continued. It has been found that for a successful rearing of the host a cooler temperature than that prevailing in the plains in August and September is necessary, and for a successful investigation of the problem a cold chamber is essential.

In BOMBAY, a detailed investigation into the borers attacking sorghum has been started with the help of the Sir Sassoon David Trust Fund.

## X. Useful Insects.

***Bee.*** The Entomological Section at Pusa continued to deal with inquiries regarding apiculture and supply improved hives, foundation comb, etc. The services of a whole-time apicultural expert are, however, required if work is to be taken up seriously.

***Lac.*** The whole of the Pusa collection of lac insects, from various parts of India and on various foodplants, has been sorted out, and a microscopical study of the specimens has been begun with a view to discrimination of the species concerned. Owing to the great rise in the price of shellac there was a large demand for supply of brood-lac and as much *ber* (*Zizyphus jujuba*) brood-lac as could be spared was sent out from Pusa.

***Silkworms.*** The Protozoologist appointed in 1919 on the PUSA staff to investigate into the more important diseases of silkworms completed his enquiry during the year, and his conclusions and recommendations have been embodied in a report recently issued. The opinion is expressed that if the practice of using examined seed is made universal, coupled with improvements in the silkworm rearing houses, in the methods of rearing and in the cultivation of mulberry, pebrine can be kept from becoming epidemic, and if all rearers could be induced to take examined seed it could be almost stamped out. The

ravages of muscardine, by adequate ventilation and disinfection of the rearing houses, could be kept greatly in check, and outbreaks could be stopped from assuming very serious proportions whenever the first dead worms were found. The rot diseases are admittedly more difficult, but much can be done by careful rearing and efficient ventilation. He therefore recommends that the rearers should be encouraged to go in for the production of disease-fee seed themselves, taught better methods of rearing, and given financial assistance to introduce necessary changes in the rearing houses.

The sericultural establishment at Pusa which had completed its pioneer work was transferred with most of the staff and apparatus to the Bihar Department of Industries.

Some of the hybrid races of silkworms evolved at Berhampur in BENGAL, which seemed promising on a small scale, were found, when subjected to a field test under village conditions, to be unsuitable. The indigenous races, on the other hand, possess great advantages on account of their hardiness and adaptability to local conditions. Work will, therefore, be directed mainly in the direction of the improvement of the local races by selection, although cross-breeding work will not be at the same time entirely neglected. Investigations into the inheritance of characters in silkworms and into the selection and cultivation of mulberry were continued.

Examined seed of the value of Rs. 79,381 as against Rs. 77,286 in the preceding year was issued from the seven nurseries maintained for the purpose. These nurseries at present produce about 10 or 20 per cent. of the seed required, and it is unlikely that the Government nursery policy could be so extended as to meet the needs of all rearers. It is therefore proposed to extend the private seed production system introduced by Rai Sahib A. C. Ghose, late Superintendent of Sericulture, to act as an intermediate agency between the Government nurseries on the one hand and the commercial cocoon growers on the other. The schools at Berhampur and Rajshahi and the classes attached to the Piasbari and Amriti nurseries are not able to meet the increasing demand for seri-

cultural education; the establishment of an additional school at Malda is therefore under consideration.

The total amount of silkworm seed reared in the PUNJAB was 2,825 ounces of eggs as against 1,726 ounces in the preceding year. The highest yield was 38 lb. per ounce of seed. There has been an increase both in the number of districts and in the number of people employed in silkworm rearing in the province. Sericulture was introduced in 124 schools as against 46 last year, and over 3,000 mulberry seedlings were transplanted on the waste banks of the Upper Bari Doab Canal.

The projected central farm at Kollegal in MADRAS has not yet materialized. In the meantime improvements such as the more careful selection of cocoons for obtaining seed, the gentle brushing of newly hatched worms, the limiting of the number of worms to each tray, better methods of cleaning the litter, the better handling of ripe worms, and the better ventilation of rearing rooms, are being systematically introduced among the rearers. Seed obtained from cocoons reared at a high altitude was found to produce not only more silk but commanded a higher price.

In BURMA, work on sericulture has been started on a small scale. The first measures taken are the supply of disease-free eggs and demonstration of improved methods of growing mulberry.

In TRAVANCORE, the Government as well as the private silk farms had a successful year. Further development of the industry was encouraged by giving financial help to selected rearers.

A few layings of disease-free seed were distributed during the year in the HYDERABAD State.

## CHAPTER IV.

### AGRICULTURAL ENGINEERING.

In spite of the inauguration of splendid systems of canals by the Irrigation Department, over large tracts of the country crop production is subject to the vagaries of a variable rainfall, and the prime need of agricultural development is for an increase in controllable water supply. No single activity of the Agricultural Department is therefore more appreciated in the districts than that of the engineering branches, who are at present mainly engaged in developing and increasing the supply from wells by subartesian bores and by the use of power pumping plants. The capacity of thousands of existing wells has already been increased and an equally large number of new wells have been dug or sunk, without having recourse to propaganda. The provision of an adequate and properly trained staff is the only requirement for the expansion of this useful work.

The question of improved agricultural implements, though of the greatest importance, is not so simple. The world has still to depend largely on designs suited to other conditions where first cost is subsidiary to efficiency, where the soil is, on the whole, more difficult to work and where levels are of much less importance. The designing of cheaper and more suitable implements has been attended with great difficulties owing to the absence, in the early days, of engineers to co-operate with the agricultural experts. Now that the existing engineering sections are being strengthened and new ones are being created, such co-operation has become possible, and some promising designs are already under trial. The problem of mass manufacture of standard types will doubtless be to a certain extent facilitated by the floating of a company subsidiary to the Tata Iron and Steel Company, at Jamshedpur, simply and solely for the manufacture of improved agricultural implements suited to Indian requirements.

In the **Punjab,** the number of bores sunk in wells amounted to 343 of which no fewer than 82·2 per cent. were successful, while borings in districts where strainers had to be used totalled 72. Three tube wells were in course of construction during the year, and proposals for more would have matured had it not been for a general feeling that the prevailing high prices of plant and machinery would decline early. The bamboo form of strainer used in parts of China has been tested and found unsuitable for Punjab soils, and trials are now being made with a straining tube of stoneware with a view to reduce the cost of the present type which, owing to high rates for metal pipes and strainers, is out of the reach of all but wealthy zemindars. The Agricultural Engineer has designed a power boring plant which is expected to reduce the boring costs to less than a half.

The demand for the Mansfield water finder to locate sites for digging wells is on the increase in the trap area of the **Bombay** Presidency for which it is specially suitable. It gave positive indications in 44 cases out of 174 tested during the year. The services of the boring machines maintained by the department are also much sought after, there being usually ten times as many applications as can be filled in any year. Of the 131 bores made, 32 were definitely unsuccessful.

In **Madras,** the work relating to pumping and well boring having been transferred to the Department of Industries, the Agricultural Engineer has been freed for devoting his whole attention to the improvement and designing of implements suited to the agricultural conditions of South India.

The engineering section in the **United Provinces** has been reorganized and considerably enlarged to meet the growing demand for tube wells and pumping installations. At the close of the year, 16 tube wells were completed and set to work, whilst 20 more were in course of construction. Of the 591 shallow borings made, 393 were successful, a percentage of 66·4.

In **Burma,** the Agricultural Engineer has been employed in carrying out tests with various makes of cane crushers and *gur-*

boiling furnaces in order to arrive at designs suited to local conditions. A furnace constructed by him shows a saving of Rs. 22-8-0 in fuel consumption per acre of cane dealt with, an important economy in working costs, but the higher initial cost of the boiling pans required is likely to retard its general adoption.

The appointment of an Agricultural Engineer has enabled the **Bihar** department to take up once more the whole work of well boring for agricultural water supplies which had for some time been shared with local bodies.

In the **Central Provinces,** four Musto boring plants worked by hand were kept fully employed during the year. An improved Akola hoe, two different types of ploughs, and a new type of pump have been designed and are now being tested.

The manufacture of the Hebbal plough on a small scale for testing on Government farms and private estates and the modification of *jaggery*-boiling furnaces to economize fuel are the two items of importance reported from **Mysore.**

Out of 45 bores sunk during the year in **Baroda,** 34 were successful. The installation of oil engines and pumps was encouraged by the loan of a sum of Rs. 68,000 to 13 applicants.

**Motor tractors and ploughs.** As was to be expected, the use of motor power for cultivation is showing signs of being of value for special purposes rather than of coming into anything approaching general use for agricultural purposes. For example, the motor tractor is now commonly met with in North Bihar on the indigo estates and is of value especially for the preparation of land for sugarcane. In the Central Provinces, it has been found useful and economical for the eradication of the deep-rooted *kans* (*Saccharum spontaneum*) grass. Although the motor tractor is never likely to be used in India for general purposes, the advent of a larger power unit may offer a solution to a considerable number of agricultural problems which hitherto have been outside the range of possibility, and for this reason it is important that types of motor tractors (which are after all the cheapest and most convenient units) suitable to Indian conditions should be worked out. Both the tractors

and implements at present on the market still require considerable modifications to be suitable to Indian conditions. What is therefore needed at the present stage is perhaps not so much demonstration as careful observation and crucial experiment conducted over a period of years by qualified experts of the department, working in co-operation with manufacturers, with a view to evolving suitable types for various purposes.

The MADRAS department, for example, confesses to considerable disappointment with the tractors purchased by them. The main use of cultivation by power in South India is the eradication of deep-rooted weeds in black cotton soils. This, writes Mr. Sampson, the late Director of Agriculture, " necessitates the land being ploughed deeply when it is in as dry condition as possible, and the period when such ploughing is possible coincides with the hottest parts of the year. None of the tractors which have so far been tried are sufficiently powerful to draw the plough except on low gear. This necessitates the engine being continually run at a high speed. What with this and the heat radiated from the ground, it is difficult to keep the engine sufficiently cool for continuous running. This is naturally a severe strain on the tractors and none of those so far tried have satisfactorily come through the rather exacting conditions which are required of them. Tractor trials, therefore, for preliminary cultivation have been held in abeyance until more suitable types of engines are evolved."

On the other hand, encouraging reports have been received from the CENTRAL PROVINCES of ploughing trials made on similar land but with different makes of tractors. In a test on very hard *rabi* land infested with *kans*, Mr. Allan found that the eradication of this weed by means of a tractor cost Rs. 40 per acre as against Rs. 68 for ploughing with bullocks and Rs. 161 for hand-digging.

In the UNITED PROVINCES, tractors have been successfully used for reclaiming heavy grass land which would have remained waste for want of sufficient labour and strong cattle. A court of wards estate owning a light tractor had paid all the work-

ing expenses of reclamation from the rent obtained in the first year, the rent of subsequent years being clear profit which would more than cover the interest on capital.

Trials with both the wheeled and caterpillar types of tractors are in progress in the PUNJAB. No proper comparison of the two types has yet been made, but on loose and sandy soils at Lyallpur the "caterpillar" has been observed to move faster and better than the "wheeled type." At present heavy implements are being used with the tractors for deep ploughing, but it is believed that as good results would probably be obtained with implements lighter in nature and covering a larger breadth.

The collation and comparison of the working costs now being collected in different provinces will be taken up when the post of the Imperial Agricultural Engineer is filled at Pusa.

## CHAPTER V.

## DISTRICT WORK.

In India the introduction of new and improved varieties of crops and of better methods of tillage does not end with mere demonstration of their advantages. It has been found necessary to create an organization for the distribution and sale of better seeds, implements and manures, as well as for realizing a fair price for the produce. This organization, which started with only a few departmental seed and demonstration farms, now embraces the activities of hundreds of co-operative societies, private seed farms and demonstration plots, agricultural associations, court of wards estates and district boards. The creation of this machinery bears evidence of not only the complexity of the task, but is also a measure of the success of the Agricultural Department in that it has brought several millions of acres under crops originally selected by the officers of the department and thousands of iron ploughs and cultivating implements into daily use. The Indian ryot has proved himself susceptible to the lure of increased returns, and the problem now before the department is not how to get into touch with him but of finding him the necessary means to finance improvements.

The whole organization for district work in **Bombay** has undergone entire change, leading to a closer co-operation between the Agricultural and Co-operative Departments, to the institution of divisional boards which control the propaganda activities of both departments, and to the definite adoption of a system of local development associations, subsidized by Government, for the carrying out of agricultural propaganda in areas which desire it. All the six divisional boards have been established, and three taluks have also formed agricultural associations each of which employs a paid demonstrator. The department has now a wealth of materials for propaganda in its improved strains of crops, better implements, new manures and more thorough methods of cultivation, which the public has learnt to appreciate, and the new organization based on popular

support should result in rapid increase in the quantity and quality of agricultural produce. It is significant that the first three taluk associations formed are in cotton tracts already growing 250,000, 70,000 and 50,000 acres of improved cotton respectively.

Seed of improved varieties of cotton sufficient to sow some 70,000 acres was sold in **Madras** through the agency of the department and the co-operative seed unions. A large amount of seed is reported also to have passed through the hands of private seed merchants. Selected strains of paddy seed were distributed to the extent of 54 tons. The department was also responsible for the distribution of over 2 lakhs of sugarcane sets and the erection of 64 *gur*-boiling furnaces on the Sindewahi model in the principal cane-growing tracts. The use of green manures on wet land after the harvest of paddy occupies a prominent place in the district work of this department, and about 75 tons of sann-hemp, *dhaincha* (*Sesbania aculeata*) and *koliniji* (*Tephrosia purpurea*) seed were sold to cultivators during the year under review. District demonstrations on the value of phosphatic manures, applied in conjunction with organic manures, are also reported to have created good impression.

The sale of copper sulphate for treating sorghum seed as a preventive against smut has now become a regular item of district work in some areas, and over 45,000 acres were sown with treated seed. Simple and effective remedies were demonstrated for the control of Rice Hispa, and the spraying of garden crops against various diseases was popularized.

Fifty-two private seed farms to supplement the work of seed supply by Government stores and farms were in operation in **Bengal.** Several khâs mahal and court of wards estates have not only started farms but are now maintaining a staff of demonstrators for propaganda work. Some of the district boards are also interesting themselves in agricultural improvement by allotting grants for distribution of seeds and manures and for employment of demonstration officers. Agricultural associations are growing equally keen to justify their existence, and in the Birbhum District alone 68 tanks were re-excavated

through their agency. The most important activity of the year is, however, the inauguration of agricultural associations on co-operative lines. These associations will raise their own share capital, maintain farms for multiplying improved seeds, and do the business of co-operative purchase and sale societies. Six such bodies have already been registered, and it is expected that the idea will catch on. With the awakening of enlightened public interest in the activities of the department the scope for district work is bound to increase. The demand for improved varieties of paddy, jute, sugarcane, etc., is already far beyond the available supplies.

In **Bihar and Orissa,** in addition to the distribution of Kakya Bombai jute, Dahia and Indrasail paddies, Pusa 12 wheat and groundnut, such operations as the cultivation and ploughing in of *dhaincha* as a green manure for paddy, the digging of drains and earthing of sugarcanes, and the construction of catchment bunds in hilly tracts, are being demonstrated. Co-operative societies proved valuable in financing the extension of improved varieties and the use of costly fertilizers such as superphosphate and gypsum. Some of them are also employing Kamdars (trained cultivators) for demonstration purposes.

The system of seed supply through depôts in the **United Provinces** has passed the experimental stage, and the financial aspect has been placed on a sound basis. During the year under review, over 2,000 tons seed of improved varieties was issued from these depôts, wheat contributing half the amount. Implements and manures are also distributed by means of the same agencies: the demand for these is steadily increasing. A feature of the district organization in this province is the establishment of private farms by wealthy zemindars. The number of these farms has risen from 202 to 300. They serve not only as seed depôts but also as centres from which improved methods spread to surrounding cultivators. The full economic influence of these farms will, however, not be felt until the owners extend their interest in the tenantry by providing them with the necessary capital for similar improvements and by entering into partnership with them in the marketing of produce. Co-

operative societies, district boards and court of wards estates are other organized units through which the department works.

In the **Punjab,** there is a cotton and wheat seed depôt for improved varieties in each circle, with sub-depôts at convenient centres. About 510 tons of wheat and 1,430 tons of cotton seed were sold at a profit of Rs. 33,000. There exist similar stores for the sale of improved implements of which 573 imported and 307 departmentally manufactured articles were disposed of. At 10 auction sales held by the department at 8 centres, about 580 tons of cotton were sold to 27 buyers.

The demonstration work has been supplemented by the opening of several farms by co-operative societies, district boards and private individuals. There are now 100 demonstration plots on the land of selected cultivators, the owners doing all the work and receiving the produce, in the Gurdaspur Circle alone.

One of the largest exhibitions of improved implements given by the department was held at Lahore at the three-days' Mela on the occasion of the visit of His Royal Highness the Prince of Wales. Practical demonstrations were given on each of the three days with most of the implements and included ploughing, cultivating, sowing, fodder cutting, cream separation and butter-making. Both the exhibition and demonstration parts of the show were exceedingly well patronised.

In the **Central Provinces,** 14 departmental and 2,237 private seed farms were at work, from which cotton, rice, wheat, sorghum and sugarcane seed sufficient to sow 389,985 acres was distributed. It is the declared aim of the department to have a demonstration and seed farm in each of the 83 tehsils of the province, but until funds permit of the attainment of this ideal, the department has to be content with such facilities as exist. More attention is, therefore, now being paid to (1) the carrying out of practical demonstrations in central villages, (2) the improvement of the cultivation on home-farms of court of wards estates, and (3) the utilization of certain jail farms as seed and demonstration centres. Arrangements made during the year for ploughing land of private individuals by improved iron ploughs and tractors on the contract system have stimulated public interest in their use. About 1,300 new implements and

a similar number of parts, to the value of Rs. 1,12,855, were sold during the year by Government farms, agricultural associations and other agencies. Two tractors have been purchased by landowners, and it is stated that more than one firm will be ploughing land " with fleets of tractors " in the current year. It is hoped that, should the latter venture prove successful, private tractor companies will be formed locally to bring weed-infested fallow land under cultivation. The growing spread of the single-seedling method of transplanting rice, wheat irrigation and the adoption of the McGlashan *gur* furnace is also attributable to persistent propaganda.

In **Burma,** about 350 tons of pure strain paddy, 17 tons of cotton seed, 36 tons of wheat, 55 tons of groundnut and a very large number of sugarcane sets were distributed. One of the most encouraging reports on district work as showing the real appreciation of the value of the department's improved paddy is that in the Bassein District an Akyozaung has built a godown to trade in improved seed. The institution of small un-official township committees of prominent landowners and farmers to discuss local agricultural problems with officials of the department is another development of great importance.

Seeds, manures and implements of the value of Rs. 64,000 were issued from the two depôts in **Assam.** The most important of the articles supplied were 93 tons of Shillong potatoes, 50 tons of bone-meal and 184 sugarcane mills. The three superior varieties of sugarcane, *viz.*, Striped Mauritius, B 147 and B 376, have become so popular, that the 25,000 sets available for distribution met only a small fraction of the demand. Successful demonstrations were carried out in several parts of the province with improved Shillong potatoes, selected strains of paddy and with water hyacinth ash as manure for jute and potatoes. The 34 honorary correspondents on the list were of considerable use in popularizing the work of the department.

During the past two years, over 30,000 fruit trees, chiefly peach, plum, apricot and pear, were distributed in the **North-West Frontier Province** from the Tarnab nurseries. Efforts are being made to prepare plants sufficient to set out 2,000 acres of true commercial orchards in the current year.

Private enterprise and the services of co-operative societies are being largely utilized in **Mysore** for distribution of large quantities of seeds of *ragi* (*E. coracana*), paddy, sugarcane and groundnut, commercial fertilizers such as oil-cakes, sulphate of ammonia and bone-meal, and improved implements. The economic transplantation of paddy and wider planting of sugarcane are two of the improved methods of cultivation which are gaining ground as the result of demonstration work. It is estimated that the department has succeeded in coming into personal touch with 10,000 agriculturists in the State and has indirectly influenced probably twice as many more.

In **Travancore,** about 9 tons of selected rice seeds, 7,125 seedlings of *robusta* coffee and 2,000 coconut seedlings were sold through seed unions. Demonstrations organized on ryots' lands have succeeded in establishing the use of various fertilizers, which were sold to the extent of Rs. 20,000. The area under single seedling transplanted paddy has more than doubled, and no less than 3,500 acres of *punja* rice lands which would ordinarily have lain fallow during the year were cultivated by adopting the methods recommended by the department.

Varieties of cotton selected on the Surat farm by the Bombay Department are spreading rapidly in the adjoining **Baroda** territory, about 50 tons of seed being distributed from State depôts. The popularity of sulphate of ammonia as a manure for sugarcane was evident from the fact that over 15,000 lb. were purchased by the farmers on their own account.

The main feature of work in the **Hyderabad** State was the distribution of pure seed of the long-stapled Gaorani cotton on the *takavi* system. It is estimated that over 5 lakhs of acres were grown from this pure seed, an increase of about 2 lakhs over the acreage in the previous year.

In eight of the eleven districts of the **Gwalior** State, the Agricultural Department has selected one representative village for demonstrating better methods of agriculture under local conditions. These villages will form not only the connecting links between the experimental farms and cultivators, but it is also aimed that they should serve as models of rural development.

Over 10,000 fruit-trees were sold to local zemindars and about 50,000 more plants were ready for distribution in the nurseries of the **Kashmir** State at the close of the year. Acclimatized seeds of the value of Rs. 2,000 were also disposed of.

## CHAPTER VI.

## AGRICULTURAL EDUCATION.

Since the reorganization of the Agricultural Department in 1905-06 the educational aspect has taken a prominent place in its activities. The efforts made were, however, devoted more to questions of higher agricultural education than to the lower stages. Colleges were started in a majority of the provinces for the training of those who wished to qualify themselves for employment in the department, as also of those who desired to turn their instruction to practical account in private farming and estate management. This dual role assigned to the colleges has been responsible for a good deal of confusion, which has only been successfully met where two separate courses have been provided. The tendency is now towards affiliation with the universities for the purpose of granting degrees in agriculture.

During the last few years the department has also become involved in the question of rural education, but the experiments hitherto made with different types of agricultural schools are by no means promising. The future lies probably with the Punjab scheme, which leaves to the Education Department to provide some agricultural training alongside a general educational training, the Agricultural Department only assisting in the way of training suitable teachers.

For **higher agricultural education,** in addition to the Agricultural Research Institute at Pusa, which provides facilities for post-graduate courses, there are agricultural colleges at Poona, Lyallpur, Cawnpore, Coimbatore, Nagpur and Sabour (Appendix III, p. 129), and it is proposed to shortly open provincial institutions at Dacca and Mandalay to serve Bengal and Burma.

During the year under review, the maximum number of students admissible to the AGRICULTURAL COLLEGE AT POONA had to be slightly reduced owing to the lack of staff and equipment. The results of the university examinations were on the whole satisfactory. Out of 47 candidates for the degree of B. Ag., 44 passed, three standing in the first class.

The AGRICULTURAL COLLEGE AT LYALLPUR continued to provide two distinct courses, *viz.*, (1) the four-year degree course which is subject to university rules and regulations, and (2) the two-year leaving certificate course. Since the affiliation of the college to the university, the standard of the candidates for admission has continued to improve. This year, out of about 300 applicants only 53 could be admitted on account of shortage of accommodation.

Twenty-seven students appeared for the B.Sc. examination, of which 14 were declared successful. Seventeen students completed the two-year course, but only 10 obtained the certificate.

Regulations for starting an M.Sc. research course have been passed by the university, but a beginning will not be possible until the staff has been strengthened.

Two courses of instruction are provided at the AGRICULTURAL COLLEGE AT CAWNPORE—the diploma course of four years designed to appeal specially to the young zemindar, to give him a sound education and concurrently to fit him to return to take an active part in the administration of his estates, and the two-year vernacular course for practical training of the small zemindar or substantial ryot who cultivates his own lands. There is an undiminished demand for agricultural education from both classes of candidates, and the large number of applications received permit of a good selection of really suitable students.

This year the results of the annual examination were very satisfactory, five of the six students in the final class obtaining the diploma, and only two of the nineteen candidates who appeared in the examination failing to obtain the certificate.

Two important developments of the year are the acquisition of an area of 380 acres for running as an estate in connection with the college to represent the capitalistic aspect of agriculture from the point of view of the large landholder, and the establishment of an up-to-date dairy which should form a valuable adjunct both for teaching and demonstration.

Steps are being taken for the affiliation and incorporation of the college within the Allahabad University as recommended by the committee which considered the subject. It is, however,

proposed to make provision for the continuation of the diploma course the demand for which comes from a class which, generally speaking, is not qualified for admission to a university, and also to arrange for the association of research officers of the department in the teaching work as far as their primary duties permit.

The separation of the diploma course from the certificate course and the stipulation that the intermediate examination shall be the minimum qualification for entrance to the former, which now leads to the degree of B.Sc.Ag. of the Madras University, have seriously affected recruitment at the AGRICULTURAL COLLEGE AT COIMBATORE.

The number of applications for admission to the certificate course showed a further drop to 95 from 252 in the previous year and 395 in 1919-20. Of these, only 23 could be admitted owing to a falling off in the intellectual standard of the applicants. The unpopularity of the course shows that its attractions for the aspirant to Government service are gone as it now leads only to the lower division of the subordinate agricultural service, and that there is still practically no demand for agricultural education for its own sake. Twenty-two students appeared for the certificate examination and 19 passed.

For the degree course, 93 applications were received but only 47 appeared for personal interviews and nineteen were selected. Most of these students are drawn from a class of people whose leanings are intellectual rather than agricultural, and it is felt that the intermediate qualification, even with a liberal offer of scholarships and the prospect of a university degree, will stand in the way of the recruitment of the right type of candidates. The situation has been brought to the notice of the Government who are moving the university to declare the certificate course, with the addition of English, a qualification for appearing for the B.Sc.Ag. examination.

Seventeen students completed the college diploma course, which is now being replaced by the degree course, and all were successful in getting through the examination.

At the AGRICULTURAL COLLEGE AT NAGPUR, the 2-year or certificate course has been definitely separated from the $3\frac{1}{2}$-year or diploma course, and only candidates of the matriculation

standard are now allowed to take the latter course. A revised syllabus of studies has been drawn up for the diploma examination, which, while maintaining a sufficiently high standard on the practical side, should render affiliation with a university easy. The number of students on the roll at the end of the year was 52, but increased to 77 in the session which began in June 1922. The results obtained in the written and practical examinations for the year were, on the whole, good.

The AGRICULTURAL COLLEGE AT SABOUR in Bihar and Orissa continued to deal with a 2-year certificate course. Twenty-two students sat for the certificate examination, of whom 18 passed, and 31 of the 34 students in the first year class were considered suitable for promotion. In view of the poor demand for agricultural education among the people of the province, it has been decided to close the college next April and no new students have accordingly been admitted in the 1922-23 session.

With the imminent discontinuance of the Sabour College, the early establishment of the proposed AGRICULTURAL INSTITUTE AT DACCA becomes imperative. It is hoped that funds will be provided without further delay to enable construction work to proceed on land which has already been acquired.

The foundation-stone of the AGRICULTURAL COLLEGE AT MANDALAY was laid on 27th August, 1921, by Sir Reginald Craddock, and it can now be definitely stated that the college will be complete with all fittings early in 1924.

Twelve post-graduate students were under training at PUSA during the year: four in general agriculture, one in economic botany, one in agricultural chemistry, three in mycology, one in economic entomology and two in agricultural bacteriology.

A scheme for the expansion of the Pusa Institute to provide training on a larger scale both for direct recruitment and promotion to the Imperial Service has been sanctioned by the Secretary of State, but the depressed condition of imperial finances makes the immediate realization of the full scheme impossible.

Five **agricultural schools** with 134 students are at work in BOMBAY, the one at Alibag having been closed during the year. The Sind school has proved unsuitable to the conditions of the province, and the question of its continuance is

under consideration. The other four middle schools at Loni, Jambul, Devi Hosur and Godhra are believed to be established successes alhough there are differences of opinion as to how they should be developed in order to obtain the maximum advantage.

A scheme has been adopted for the experimental organization of a number (not exceeding 20) of primary schools with a pronounced rural outlook and teaching with a definitely agricultural complexion. The teachers for these schools in the Marathi areas are being trained at the Loni school.

There are two agricultural middle schools in MADRAS, the one at Taliparamba with 18 pupils and the other at Anakapalle with six students on the rolls. Special text-books for these schools and also for the use of teachers in the elementary schools of the Coimbatore District have been prepared.

The two agricultural middle schools at Dacca and Chinsura in BENGAL have been converted into secondary agricultural schools for giving a higher form of training to the sons of peasant proprietors or those who have a direct interest in the land. The curriculum is designed so as to train the students to farm their own lands or become demonstrators in the department or teachers in elementary agricultural schools a number of which are to be started as an experimental measure. The progress made by the agricultural classes attached to the Amarpur middle English school and the Durgapur high English school is not very encouraging.

The Bulandshahr agricultural school in the UNITED PROVINCES started working on the 1st October, 1921, with 33 students, the number of applicants being more than could be admitted with the present accommodation. The school aims at giving a thoroughly practical course for the sons of small zemindars or substantial tenants who will return to work their own holdings. It thus repeats, in essentials, the certificate course of the college with the difference that the appeal is purely local. When the college is affiliated to the university, it is proposed to transfer the certificate course to several such schools in different typical tracts.

The attendance at both the Chandkhuri and Powarkhera middle schools in the CENTRAL PROVINCES fell considerably

during the year, the number on the rolls being 18 and 6 respectively as compared with an accommodation for 32 in each. As there is apparently no demand for the kind of semi-vocational training given in these schools, it is now proposed to experiment in the direction of giving a course of agricultural instruction in the ordinary vernacular middle schools of the Education Department.

There are no special agricultural schools in the PUNJAB, but ordinary vernacular middle schools are utilized for imparting a practical training in agriculture to school boys in rural areas. The special features of the scheme are that (*a*) a farm is attached to the school with an area and equipment sufficient for practical training on a reasonably large scale, and that (*b*) the training is given not by one of the ordinary school teachers but a teacher specially selected for the work and trained for a year at the Agricultural College at Lyallpur. The scheme has achieved an immediate popularity, and arrangements for the teaching of practical agriculture are already either in progress or nearing completion in about 50 institutions, or a quarter of the total number of vernacular middle schools in the province.

Land has been acquired for the proposed agricultural school at Pyinmana in BURMA, and the American Baptist Mission, which is to be in charge of it, hopes to begin teaching in 1923.

Twenty-three students were under training at the Hebbal school in MYSORE which conducts a three-year course in English. The demand for admission has gone down partly due to the fact that the prospects of Government employment have become considerably less owing to the financial stringency. The other school at Chikkanhalli, which has been conducted as a grant-in-aid institution for the last seven years with a vernacular course extending over 12 months, has been handed over to the department by the original donor. Under the new arrangements it will be possible to improve the course and extend the usefulness of the school.

There were 250 applications for admission into the agricultural middle school opened during the year at Alwaye in TRAVANCORE which has accommodation for only 32 students.

**Short courses.** The six months' practical vernacular course at LYALLPUR was taken advantage of by 24 students, seven of whom were employees of the Co-operative Department and the rest sons of farmers. Seventeen senior vernacular teachers took the course to qualify themselves to teach agriculture in rural middle schools of the Punjab. All these men showed signs of very careful selection for the purpose for which they were trained and showed great aptitude. The rural economy class at the same college, which lasts for a month, was attended by four Assistant Commissioners, five Extra Assistant Commissioners, 8 Zilladars and other canal officers, and five Co-operative Department inspectors. Officers trained in this class have proved of great assistance to the department in introducing improvements in their jurisdiction.

The one-year short course for farmers' sons with a knowledge of English was not held at the POONA College as the syllabus is under revision.

Two students attended the *bhadoi* (monsoon crop) short course and one the *rabi* (winter crop) short course at the Sabour College in BIHAR. Two stipendiary students and three probationary overseers were also under training on the Kanke farm.

Short practical courses in general agriculture have been started on two farms in the CENTRAL PROVINCES, and on the Nagpur farm a three months' training in the driving of motor tractors and the handling of tractor implements was given during the year to about 20 men.

A class has been opened with 10 students on the Mandalay farm for training of junior agricultural assistants required by the BURMA department. Short courses held on the Hmawbi and Mahalaing farms for cultivators are being well patronized. A scheme has also been sanctioned for training of engine-driver apprentices.

In ASSAM, 17 apprentices were under training on different farms of the province for employment as demonstrators.

The schools for juvenile and adult labourers on the farms at Coimbatore, Palur and Anakapalle in MADRAS continued to function, but the results are reported to be not commensurate with the expenditure.

## CHAPTER VII.

## THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

A steady increase in the number of credit societies, which provide the agriculturist with the necessary capital at reasonable rates, and of others designed to obtain the best value for the products of his labour (Appendix IV, page 134), and a closer association with the Agricultural Department are features which mark the work of the Co-operative Department during the year under review. Cattle-breeding, cattle insurance, and dairy societies have failed to make any headway in most provinces, but societies established for such purposes as irrigation (in Bengal), consolidation of holdings and silt clearance (in the Punjab) indicate lines on which co-operative effort may be used to great advantage.

The following facts and figures culled from provincial co-operative reports give some idea of the progress of the movement during the year.

**Bombay.** The growth in the number of agricultural credit societies continues to be satisfactory. The total number is now 2,753 as compared to 2,382 in the preceding year and 1,993 in 1919-20. The working capital has increased from Rs. 133½ lakhs to Rs. 160 lakhs and the reserve fund from Rs. 9½ lakhs to Rs. 10·8 lakhs. A weak point of these societies, however, is the large percentage of overdue debt. This aggregates 13 per cent. of the working capital and amounts to Rs. 19½ lakhs as against Rs. 16 lakhs in the previous year and Rs. 8½ lakhs in 1919-20.

The number of non-credit agricultural societies rose from 110 to 146. The best developed type in the presidency is the cotton sale society of which there are now 13. In spite of a rather unfavourable season the total value of the goods sold by co-operative sale societies amounted to no less than Rs. 22 lakhs of rupees. Most of the 90 societies registered for the supply of seed, manure or agricultural implements are on a very small

scale but some, especially those dealing in seed, did useful work during the year. Two societies for collective cultivation were registered during the year, these being the first of the type in the presidency.

The Co-operative Institute, the central consultative and propagandist body in the presidency, continues to extend its activities. It has now six branches and a membership of 2,799 societies and individuals. Training classes conducted by the Institute were helpful in training a large number of secretaries, honorary organizers and bank managers. The Provincial Conference was this year entirely managed by the Institute and proved a great success. An innovation of holding a joint session with the Presidency Agricultural Conference was so successful that it was decided to make this a permanent feature of the conferences.

**Madras.** There was a net increase of 999 in the number of agricultural credit societies in the presidency, raising the total to 6,206. The total working capital rose from Rs. 1,84,47,619 to Rs. 2,22,92,429, and the reserve fund from Rs. 9,66,643 to Rs. 10,88,407. Although many of the societies failed to earn a divisible profit during the year, it is clear from the figures of the book profit and of the real loss that, on the whole, they are quite sound financially.

The number of non-credit agricultural societies rose from 67 to 80 during the year. Several of the societies made a net divisible profit, while others incurred a loss. The Kallakurichi Taluk Agricultural Society, the Garden Planters' Society, the Bunts *alias* Nadavars Co-operative Wholesale Society, the Shiyali Agricultural and Industrial Society and the Nidamangalam Manure Society did good work during the year.

**Bengal.** The number of agricultural credit societies rose from 5,787 to 6,047 and membership from 162,287 to 170,067, while working capital increased from Rs. 1,22,62,188 to Rs. 1,30,80,811.

The development of agricultural non-credit societies, though slow, has been steady, the number increasing from 63 to 99. The most remarkable progress has been with irrigation societies which increased from 7 to 29. The additional 22 societies have

been registered in the Bankura District well known for its precarious rainfall but with a natural configuration lending itself to small irrigation projects. A demand for such societies has also sprung up in the adjoining district of Birbhum. Co-operative agricultural associations for the purpose of promoting the agricultural interests of the members are a new venture which has been taken up this year. Of the four bodies registered, only one commenced activity within the period under review. The financial position of the Naogaon Ganja Cultivators' Society continues to be a very strong one. Out of the profit of Rs. 3,46,517 earned during the year, Rs. 17,506 was bestowed on various charities, educational and medical. Considerable sums were also devoted to improvement of roads and embankments.

The Bengal Co-operative Organization Society continued to carry on propaganda through its two journals and by organization of public lectures. The question of its reorganization and the expansion of its activities in other directions is engaging the attention of the department.

**Punjab.** The number of agricultural societies of different types increased from 8,014 to 8,757, membership from 2,12,375 to 2,38,668, working capital from Rs. 2,21,11,467 to Rs. 2,52,60,655, and reserve fund from Rs. 51,97,345 to Rs. 57,47,407.

The Jhang Mortgage Bank had another year of successful work. During the year under review it advanced Rs. 60,973 to its members and thus brought about redemption of 1,025 acres of land and 763 date palms.

The two co-operative seed and demonstration farm societies in Montgomery and Lyallpur did very useful work and sold about 270 tons of pure seed, 423 Meston ploughs and a large number of other implements. They are now unable to meet the growing demand. A society for better farming has recently been started in Gujrat, and a few villages with good societies have been selected for intensive propaganda in the direction of improved farming.

At the end of the year under review there were 107 societies for consolidation of holdings as against 60 in the preceding

year, while 27 more have been organized but not yet registered. The area consolidated during the year is over 8,500 acres in 15,474 scattered fields into 2,197 compact blocks. The scheme is becoming increasingly more popular.

Another useful type of society in this province is that for clearance of silt in the inundation canals. There are now 12 societies of this type. Through the work of these societies it is calculated that the members have benefitted to the extent of Rs. 430 per individual during the year from the increased acreage of produce.

**United Provinces.** The number of agricultural credit societies rose from 4,213 to 4,848, membership from 1,01,613 to 1,16,442, and working capital from Rs. 57,38,326 to Rs. 64,34,911.

The number of non-credit societies remained unchanged at 10. A *ghi* society was dissolved and a cattle insurance society was registered during the year.

**Central Provinces.** The conditions prevailing during the year were unfavourable to expansion and the activities were wisely confined to consolidation. The number of agricultural credit societies fell from 4,535 to 4,496, membership from 73,879 to 73,112, and working capital from Rs. 1,24,77,607 to Rs. 1,22,23,249, but the reserve fund rose from Rs. 9,66,867 to Rs. 12,92,504 and the profit from Rs. 2,30,924 to Rs. 3,26,957.

The number of agricultural societies for purposes other than credit decreased from 34 to 32. The registration of the two cattle-breeding societies had to be cancelled on account of the apathy of members. Seed unions performed, as usual, very useful service in distributing and encouraging the use of pure seed. A commission sale society organized during the year disposed of cotton and sorghum of the aggregate value of Rs. 2,22,592, earning a net profit of 21 per cent. on the paid up share capital. Of the six registered agricultural associations, three in Berar made good profits, chiefly by the hire and sale of iron ploughs.

**Burma.** There are now 4,023 agricultural credit societies in Burma. During the year, membership increased from 89,103 to 93,518, working capital from Rs. 1,44,53,403 to

Rs. 1,69,75,843, and reserve fund from Rs. 21,91,797 to Rs. 26,50,930.

The number of purchase and sale societies remained stationery at 17, while there was an increase of 12 societies for production and sale. The 67 societies of the latter type at work during the year sold goods worth nearly Rs. 4½ lakhs to members. The two production societies remained inactive.

**Bihar and Orissa.** The number of agricultural societies rose from 3,247 to 3,861, membership from 95,112 to 1,12,421, and working capital from Rs. 48,32,591 to Rs. 64,04,598 during the year under review. The reserve fund also increased from Rs. 6,77,286 to Rs. 8,44,356.

Sustained progress was made during the year in the matter of agricultural improvements. Large quantities of improved seeds of different varieties of crops were distributed and several wells and bunds were completed during the year. Schemes for irrigation by means of power-driven pumps have also been taken up. The agricultural sale societies have, however, not been quite satisfactory. The number of grain *golas* (stores) rose from 31 to 72 and these made excellent progress. These *golas* afford relief to the members in the shape of loans at very low rates of interest and serve as a reserve stock for use during years of scarcity and famine.

**Assam.** The number of agricultural societies rose from 494 to 555, membership from 21,638 to 24,579, and working capital from Rs. 5,15,279 to Rs. 7,07,211. The capital available per member is, however, still inadequate. There are no societies for agricultural production or for the sale of produce.

### Co-operative Cotton Sale Societies.

In Bombay, there are 13 societies for the sale of cotton only. Six of these are situated in the Southern Division of which by far the most successful are those at Hubli and Gadag, and sufficient experience has now been obtained to indicate the conditions essential to success. It has been found that the small societies, started in the first instance to localize sales, had been useless, as they did not attract buyers, and it appears necessary that such societies should be established at large

markets. The co-operation of the local trade is also an essential to success. The Hubli and Gadag societies have been criticised for admitting local *dalas* (brokers) to membership and it has been urged that the society should attempt to replace the *dalal;* this, however, has been found to be unworkable.

It has also been found essential that the societies should be able to offer definite attractions to large buyers. At Gadag and Hubli, the sale by auction of considerable quantities (aggregating the equivalent of a thousand bales on a single date) of graded *kapas*, chiefly the produce of selected seed issued by the Agricultural Department, has brought to the auction important mill and export buyers in a position to offer full prices. Grading by the staff of the Agricultural Department for cleanliness, purity and ginning percentage has been a large factor in the success of the auctions. These sale societies have also been the means of ensuring a supply of seed of selected varieties, far larger than the department could itself control.

If, however, sale societies are to really affect the marketing problem generally, as distinct from ensuring a profitable market for new varieties in the early stages, their organization and finance will require careful consideration. The present societies issue to the growers, who, it may be noted, are all substantial men handling considerable quantities of *kapas*, receipts for *kapas* deposited with the society in which the weight delivered is stated and also, by arrangement with the co-operative credit societies, an advance of part of the price. It is essential in many cases that the cultivator should be able to receive at once a very large percentage of the price of his *kapas* failing which he may be driven to sell elsewhere. Auctions must necessarily be few in number, and with a falling market it is clear that the society needs means of protecting its members against loss. The selling of hedge contracts affords a means of materially reducing these risks, but safeguards against any form of speculation would be necessary.

### Co-operative Milk Societies.

It is satisfactory to note that the set-back to these societies in BENGAL mentioned in last year's report has been almost

entirely removed and their number has risen from 40 to 47. The societies are now supplying on an average about 3,000 lb. of milk per day to Calcutta where on its arrival the produce is handled by the societies' union.

In the CENTRAL PROVINCES, the net profit of the two societies of *gaolis*, which work in conjunction with the Telinkheri dairy at Nagpur, amounted to Rs. 11,036. The members who number 24 now own 456 animals including 113 head of young stock. Some of the *gaolis* had the honour of supplying milk for the use of His Royal Highness the Prince of Wales: they showed up well on the occasion by allowing their cows to be subjected to the tuberculin test and to be segregated for some weeks.

Among the dairies in the UNITED PROVINCES, the Katra Co-operative Dairy, Allahabad, has continued to do useful work and made a profit of Rs. 630 on the year's working. The dairies at Lucknow and Benares are, however, slowly declining.

The Milk Society of Gurdaspur in the PUNJAB continued to sell milk for its members. The milk sellers proved hostile to the society, and attempts to organize consumers failed.

## Cattle Insurance.

The number of cattle insurance societies in the PUNJAB rose from 38 to 42. Funds also increased from Rs. 3,133 to Rs. 3,404 but premia collected during the year declined from Rs. 1,927 to Rs. 1,767.

In BURMA, the number of registered societies rose from 381 to 383, but there was a decrease from 3,488 to 3,056 in the number of cattle insured and also in the amount of premia collected from Rs. 5,023 to Rs. 3,957.

An insurance society has been started at Jarauli in the UNITED PROVINCES, but it will have to be carefully nursed at least for sometime to come.

There are now nine cattle insurance societies in BOMBAY. Prospects for this class of society are reported to be hopeful in Gujarat.

## CHAPTER VIII.

## LIVE STOCK.

### I. Prevention and Treatment of Disease.

Details of the work done by the Civil Veterinary Departments during the year under review are given in tabular form on page 138 (Appendix V). Forty-two new hospitals and dispensaries were opened, bringing the total to 616. The number of cases treated and castrations performed at these institutions rose from 10,96,834 in the previous year to 12,42,751. A similar increase in the number of animals treated by itinerant veterinary officers is to be recorded, the figures for the two years 1921-22 and 1920-21 being 7,68,984 and 6,76,131, respectively, thus showing a growing confidence of the agricultural population in the medical treatment of their live stock. There are also indications that private persons are beginning to take a practical interest, in some parts of India at any rate, in veterinary matters. In Bombay, one dispensary and an in-patient shed were built during the year with the help of funds collected by the people, while in the Punjab the department received substantial offers of help for four hospitals from private individuals. In the latter province, co-operative societies are also displaying keenness in providing medical aid for the stock of their members, and it is hoped that the time for starting co-operative veterinary dispensaries is not far distant.

Taking India as a whole, there are indications that live stock suffered less from contagious diseases during the year than in the previous season. The total number of deaths of cattle reported amounted to 2,37,332 as against 2,88,375 in the preceding year and 3,37,396 in 1919-20. While too much importance should not be attached to the absolute value of figures depending on a reporting agency, they do afford an indication of the relative intensity of the contagious diseases from year to year.

With the decrease in the reported mortality from contagious diseases, there was a sympathetic reduction in the number of

preventative inoculations carried out, *viz.*, from 8,56,583 to 7,15,691. Over 99 per cent. of these animals passed through the epidemic safely, and more could have been saved if outbreaks were only reported promptly. In the Punjab, Rs. 6,000 have been provided in the budget for payment of rewards to *patwaris* for good work in reporting outbreaks of cattle disease, and it is to be hoped that some similar inducements may be given in other provinces to stimulate promptness in reporting. It must, however, be acknowledged that just as many cattle are lost owing to the inability of the departments, through being understaffed, to meet all the calls made on them for help during periods of epidemic, as through the inefficiency of the reporting agency. For example, it is stated that in Madras over 12 per cent. and in Bihar and Orissa nearly 30 per cent. of known outbreaks remained neglected for want of men to attend to them. In India, as in other countries where the main stay of the farmer is his live stock, adequate veterinary assistance, whether for inoculation, vaccination or treatment, is a *sine qua non* of rural prosperity, and it is regrettable that many local boards, upon whose financial assistance the department is dependent for district work, are still unwilling or unable to hasten the progress of prevention and control of contagious diseases by employing even the minimum staff which the Veterinary Department considers necessary.

## II. Incidence of Disease.

*Bombay.* The comparative mildness which characterized the outbreaks of contagious diseases of cattle in 1920-21 was more than counter-balanced during the year under review, the number of recorded deaths rising from 7,752 to 15,256. The increased mortality was due to the greater prevalence of rinderpest which again showed a tendency to confine itself to the Northern and Central Divisions. A record number of cattle, *viz.*, 59,686 were reported to have been attacked with foot-and-mouth but the mortality amounted to only 233. Village officers are still apt to neglect the reporting of outbreaks but steps have been recently taken to secure more accuracy and promptitude.

*Madras.* Although there was an increase in the number of deaths reported from hæmorrhagic septicæmia, black-quarter and foot-and-mouth disease, the total reported mortality from contagious diseases dropped from 37,066 in the previous year to 34,258 during the year under report. Rinderpest which was severe only in the Ganjam and Kistna Districts and in the Agency Division accounted for only 10,121 of the deaths recorded. Bovine lymphangitis continued to be very prevalent, and a large number of cases of trypanosomiasis in cattle were reported. The Bantanahal sheep-breeding farm has been closed down owing to the ravages of pleuro-pneumonia.

*Bengal.* There was an appreciable decrease in the mortality of animals from contagious diseases, the total number of deaths reported being 16,142 as against 19,344 in the preceding year. Rinderpest, although showing considerable decrease on last year's figures, was responsible for nearly three-fourths of the total mortality. There was a satisfactory decline in the death rate from anthrax and foot-and-mouth disease. No cases of surra or dourine were reported during the year.

*Bihar and Orissa.* Contagious diseases of cattle were responsible for 28,655 deaths as against 29,204 in 1920-21. All districts without exception reported rinderpest and hæmorrhagic septicæmia. The virulence of the former disease was not so great in the northern areas, but heavy mortality was recorded in most of the southern districts. Hæmorrhagic septicæmia appeared with greater virulence than in the previous year and accounted for 4,393 deaths.

*United Provinces.* There was a further and gratifying decrease in the number of deaths from contagious diseases, the total reported mortality being 11,029 as against 19,502 in the previous year and 42,715 in 1919-20. Very few districts were in fact seriously affected with rinderpest, and only 5,976 deaths were recorded compared with 15,296 of last year. Foot-and-mouth was another scourge from which the province suffered less severely than usual, the mortality being chiefly confined to young stock or to old, weakly and decrepit animals.

*Punjab.* The continuance of the fodder shortage found the condition of cattle generally below normal, with the result

that the reported deaths from contagious diseases rose from 25,200 to 42,244. Both rinderpest and hæmorrhagic septicæmia appeared in almost all the districts of the province, and the very general movement of animals in search of fodder created fresh centres of infection. Only 17 deaths were reported from surra as compared with 37 in 1920-21. No case of dourine was reported for the third year in succession, a gratifying testimony to the efficacy of the thorough measures taken to suppress the disease in 1919. There were 17 cases of equine abortion on the Hissar farm as against 45 last year, and steps are being taken to eliminate or at all events to obtain more effective control of the disease.

*Central Provinces.* The return to normal conditions after the scarcity of 1920-21 was reflected in the general health of cattle during the year under review and in the diminution of epidemic disease. Reported deaths from contagious diseases numbered only 14,144 as against 46,243 in the previous year. Rinderpest appeared only in mild form and removed 10,022 cattle compared with 41,725 of the preceding year. Sixteen cases of trypanosomiasis in equines and twelve among bovines were confirmed microscopically. Piroplasmosis was successfully treated with intravenous injections of trypan-blue.

*Assam.* The year appears to have been a comparatively healthy one for stock, the recorded number of deaths from contagious diseases being 30,594 against 47,083 in the previous year. The decrease in the mortality from rinderpest was particularly marked, being only 9,855 head compared with 20,003 in 1920-21. There were 80 deaths from surra, which were more than double of what occurred in the preceding year.

*Burma.* The total number of deaths from contagious diseases further dropped to 27,437 in the year under review from 40,409 of the previous year and 59,425 of 1919-20. Rinderpest, the principal contributory cause, was particularly mild in Lower Burma, but levied a heavy toll in Upper Burma where it was mostly confined to buffaloes which in many tracts live in a semi-wild state. Many of these died in the streams of the Chindwin river and their carcases floated down considerable distances before discovery, probably thus spreading the infection. The Shan States were singularly free from

cattle diseases, and only three deaths from rinderpest were reported to have occurred.

*North-West Frontier Province.* The mortality from contagious diseases rose from 1,067 in the preceding year to 3,106 in 1921-22. Of the latter, 1,193 deaths were claimed by rinderpest and 781 by hæmorrhagic septicæmia. Only 10 cases of surra were reported as against 40 last year, and no case of dourine was detected as in the previous year though a strict look-out was kept for any suspicious case among animals brought to different fairs.

*Sind.* Effect having not yet been given to the proposed separation of the veterinary charge of Sind from that of Baluchistan and Rajputana, the expected improvement in control of disease did not materialize. There was a still further spread of rinderpest which was already very prevalent in the preceding year, and the reported mortality from contagious diseases increased from 10,564 to 13,798. Ten cases of glanders and 28 of surra died or were destroyed as against 45 and 91, respectively, in 1920-21.

*Baluchistan.* Rinderpest was less rife than in the previous year, and the number of reported deaths dropped from 4,685 to 545.

*Rajputana.* There was a reduction in reported mortality from contagious diseases from 256 to 124. Seventy-six animals died of rinderpest.

## III. Preventive Inoculation.

The smaller incidence of disease among the bovine population reduced the demand, from the Provincial Veterinary Departments, for the products of the IMPERIAL BACTERIOLOGICAL LABORATORY AT MUKTESAR which issued during the year 22,66,066 doses of different sera and vaccines for the inoculation of 7,15,691 animals. The laboratory, however, prepared more sera than the average of the preceding five years. It is anticipated that, with the recent reorganization of the serum-making department and the opening of the plains station at Kurgaina, the combined resources of Muktesar and Bareilly will be sufficient to meet for some time to come the capacity of the veterinary personnel throughout India in applying serum

treatment in the field. The question of establishing a few cold storage centres in the provinces will have none the less to be taken in hand, so that at times of urgent demand the isolated position of Muktesar may not act as a handicap in obtaining immediate supplies and the breakdown of railway transport may not deprive large numbers of cattle of the much needed treatment as it did last year in some of the areas served by one of the railway companies.

Rinderpest levies every year a heavier toll on Indian cattle than do all other contagious diseases combined in a decade, and the inoculation operations are mainly directed for the control of this scourge. Of the 7,75,700 bovines inoculated in 1921-22 throughout British India and Mysore (the only State for which figures are available), as many as 597,841 were protected against rinderpest by the " serum-alone " method of inoculation. This method has been adopted in India not because it is the best means of dealing with the disease itself, but because it is most suitable for the very special conditions of Indian administration. It merely confers a transient, passive immunity which carries an animal through an outbreak, and the treatment has to be repeated every time that a fresh outbreak occurs. That it serves its purpose well will be evident from the fact that while the normal mortality from cattle plague is 75 per cent., the actual deaths from animals inoculated last year with anti-rinderpest serum amounted to only 0·36 per cent. It is, however, generally acknowledged that, despite the fragility of the virus, the only sure preventive against this disease in a country where segregation measures cannot be effectually enforced is the widespread active immunization of the bovine population so as to render them subsequently immune for the remainder of their lives against attack. Such a preventive is available in the " serum-simultaneous " method which has given excellent results in military dairies and in Government cattle farms. Its general adoption is, however, attendant with many risks. In the meantime inoculations are now being made with it on a small scale in herds of private cattle, and the results will be watched with much interest.

Prophylactic measures against hæmorrhagic septicæmia consist of anti-serum inocuation when an outbreak has actually

occurred and of preventive vaccination of animals in low-lying villages liable to visitations of this disease. Of the 92,600 animals inoculated with serum during the year, only 0·05 died; while the 57,850 vaccinated bovines had only one death among them. Although only a certain percentage of animals are attacked when the disease breaks out in a village, it runs such a rapid course that it allows very little opportunity, under the present dilatory system of reporting, for inoculations to be carried out in time. The practice adopted in the Punjab of vaccinating cattle in marshy areas before the break of the rains requires to be more widely followed.

Anthrax and black-quarter are other contagious diseases of bovines against which preventive measures are taken on a considerable scale. Results of injections made during the year indicate that the mortality among inoculated cattle do not exceed 0·52 and 0·20 per cent., respectively.

In Madras, the Cattle Disease Act, which empowers the keeper of a hospital pound to impound every animal found to be suffering from a contagious or infectious disease, was put in force at all the important cattle fairs and throughout the Nilgiri District. Owing to the agrarian trouble in the Guntur District no pounds were established on the routes of cattle returning from grazing in the Hyderabad State. Altogether 22 municipalities have upto the end of March 1922 adopted the model bye-laws relating to the maintenance of cattle mortality registers. An important and salutary provision of these rules is that they lay upon owners of animals the duty of reporting deaths to the council, thus enabling the Veterinary Department to deal promptly with outbreaks of contagious disease. Other Local Governments and Administrations might also see their way to considering the advisability of introducing similar measures in their provinces.

## IV. Veterinary Education.

For the training of students in veterinary science, there are colleges at Bombay, Madras, Calcutta and Lahore, and schools at Insein and Taunggyi in Burma.

The colleges at Bombay, Madras and Calcutta give a three-year diploma course in English. At Lahore, Urdu used to be

the medium of instruction extending over the same number of years, but during the year under review a revised course has been introduced which covers a period of four years and demands better educational qualifications from the students who enter the college. The total number of students who passed the final examinations of the colleges during 1921-22 was 149 as against 130 in the preceding year (Appendix VI, page 139). The veterinary schools at Insein and Taunggyi impart instruction in the vernacular for three years and a year and a half, respectively. Fifteen students got through the final examination at Insein.

The plans and estimates for the proposed veterinary college at Lucknow are now before the Local Government, but it appears unlikely that the buildings will be commenced for some time to come. A proposal is also afoot for the establishment of a veterinary college for Bihar and Orissa.

The necessity for improving the standard of training afforded by existing colleges has long been felt, and the revision of the course of studies at the Lahore college is the first move in that direction. A preliminary step towards raising the level of veterinary education in this country is, however, the attainment of uniformity in the standard required by the various institutions. The necessity for this is fully realized by the Government of India and the Local Governments, and a meeting of principals of veterinary colleges and other senior veterinary officers was accordingly held at Bombay in February 1922. A full and comprehensive scheme was drawn out and is at present under the consideration of the Governments concerned.

Pending the provision of higher veterinary training in India for students to qualify them for direct appointment to the Imperial Service, five State scholars have been sent to England. At the same time a scheme has been formulated for post-graduate training of officers of the provincial grade selected for promotion to the Imperial branch of the service at the Imperial Bacteriological Laboratory which has unrivalled resources for veterinary education. Under this scheme, which is on trial for two years, six officers are at present undergoing

instruction at Muktesar. On the results of this latter experiment will depend the laying down of a definite policy for the Indianization of the Indian Veterinary Service.

Besides the regular students, four dressers and 16 farriers were trained at Lahore, while at Calcutta 17 students of the public health class had a course of practical training in the diseases of animals transmissible to human beings, 80 students under training as Sanitary Inspectors were given a course of lectures and demonstration of infectious diseases of animals, and two sepoys were trained as farriers. Six students passed out during the year from the veterinary compounders' class attached to the Nagpur hospital.

The United Provinces Veterinary Medical Society started in 1912 continues to do good work, and is publishing an Urdu veterinary journal. In Bengal, veterinary union committees organized in the previous year to co-operate with veterinary officers in the matter of combating outbreaks of cattle diseases and the improvement of cattle in general are doing useful work, and similar bodies are being formed in other districts. Leaflets dealing with prevention and treatment of cattle diseases were, as usual, freely distributed, and lectures on animal diseases, hygiene, cattle-breeding, cultivation of fodder crops, etc., given to cultivators and stock owners congregated at fairs and shows.

## V. Veterinary Research.

*Rinderpest.* Valuable work was done at Muktesar in obtaining further knowledge with regard to anti-rinderpest serum, the classes of bovines from which it could be prepared, methods of estimating its potency, and the duration and character of the immunity following upon inoculation.

The ability to produce serum from cattle of relatively low susceptibility as virus producers is of primary importance for countries like India where rinderpest is widespread and where there are no highly susceptible cattle available. The Muktesar experiments have shown that a sufficiently potent serum can be prepared by the use of virus obtained from animals moderately

susceptible to the disease such as young male plains buffaloes, and that the continued use of buffalo antigen does not produce any deterioration in the potency of the serum prepared up to one lakh and ten thousand doses involving thirty-four sub-passages. The results are of immediate practical importance inasmuch as the Muktesar laboratory need not in future depend entirely for virus producers on the Kumaon hill cattle the supply of which is becoming increasingly difficult. The chief obstacle to the establishment of a second laboratory in South India, when one is considered absolutely necessary, thus also disappears.

Further experiments on rinderpest at Muktesar have shown that a single dose of anti-rinderpest serum confers a passive immunity for nine days, that increased doses of serum prolong the immunity but not in proportion to the increase, and that it is reasonable to assume that serum simultaneous inoculation confers an immunity for at least the average life of a beast.

*Surra.* The study of surra is receiving attention both at Sohawa and Muktesar. Further experiments by Mr. Cross in the treatment of this disease by tartar emetic showed that at least 28 grammes must be injected to effect a cure, but it would be advisable to inject more if the animal is tolerant of the drug. Seventy-seven camels were successfully treated during the year at the laboratory, and the cost of the drug per animal amounted to only four to five annas. The investigation is being continued with a view to reduce the number of doses, if possible, and to ascertain the possibility of preparing an emulsion of tartar emetic which can be injected intramuscularly without producing suppuration. A prolonged series of researches are also being planned at Muktesar with the object of ascertaining which of the trypanocidal agents claimed to have rendered beneficial results in treatment represent the most economical and easily applicable in field conditions. The transmitting agent of surra continued to engage the attention of the Camel Specialist who reports that whereas tabanidæ so far appear capable of spreading the disease by direct transmission only, there is probably a cycle of the trypanosome within a new species of Ornithodorus collected in course of the fly survey.

Further experiments carried out to ascertain the course of camel surra in other animals indicate that the blood of buffaloes, sheep and goats remains infective for many months, though these animals may appear healthy and no trypanosomes are found in their blood.

*Contagious abortion.* The methods of controlling contagious abortion in mares and donkeys are being systematically studied at Muktesar in conjunction with the Superintendent of the Hissar Cattle Farm. Early diagnosis being an important factor in the control of this disease, a periodical examination of the blood of all equidæ on the farm has been started.

*Mange.* In view of the amount of mange material available, the efficacy of various acaricidal agents is being tested at Muktesar, and results of considerable practical importance are expected.

*Strangles.* With the co-operation of the Army Department material from cases of strangles is being investigated at the Imperial Bacteriological Laboratory, and an endeavour is being made to obtain a satisfactory method of prophylactic treatment.

*Sheep disease.* The Muktesar laboratory has also undertaken an investigation into the causes of the ravages of pleuro-pneumonia on the Bantanahal sheep-breeding farm. A preliminary report has already been supplied to the local department, but more material is required for further work and this may be difficult to obtain now that the farm has been closed down.

## VI. Breeding.

(*a*) ***Cattle-breeding.*** The important part played by cattle in the agricultural economy of India makes their improvement in breed and maintenance in good condition a matter of first concern. While the cattle are almost certain to benefit by a general improvement in the outturn of grain and other crops, it must be admitted that in the whole range of agricultural endeavour in India no other question has received less detailed and co-ordinated attention as the live-stock industry. This has not been due to want of earnestness or realization of the

gravity of the problem on the part of either the Agricultural or the Veterinary Department who have done their best with small staffs and equally small budget grants, but that best has been totally inadequate to meet the situation created by the ruthless operation of economic laws.

The gradual pressure of population has resulted in a serious encroachment on grazing areas which formerly contributed to the maintenance of the cattle. Outside the canal-irrigated areas it is now found practically impossible over the greater part of India to grow crops purely for fodder purposes, and the result is a cattle population which subsists almost entirely on crop residues. Badly fed draft cattle result in bad cultivation, which in turn results in poor outturns, both grain and fodder—a vicious circle, like that of wages and high prices, which is difficult to break. The only visible solution is the establishment of animal husbandry on a sound basis. The establishment of farms with the object of evolving, both by grading up and cross-breeding, a dual purpose animal which will not be unprofitable to keep on arable land, an efficient system of making good breeding bulls available in the countryside, the introduction of fodder catch crops, where irrigation is possible in the cropping system, and of green crops for mixing purposes where the existing diet is straw alone, and provision of up-to-date training in dairy industry, are obvious lines of work. Some of these have more or less been attempted in most provinces. That the present activities are not commensurate with the immensity of the problem was recognized by the Board of Agriculture which last year reconsidered the whole question in all its bearings. They, therefore, recommended the creation in every province of a special section of the Agricultural Department devoted to cattle-breeding and dairying, the immediate commencement of the proposed dairy school, and the establishment of an Imperial Cattle Board to formulate and carry out a general cattle-breeding policy. The present financial stringency may not allow the Government to accept these recommendations *in toto*, but it is time that the policy of half-measures leading to nowhere is replaced by one of co-ordinated and sustained effort in dealing with a question which, if long neglected, might easily assume more serious proportions.

At PUSA, as explained in previous reviews, cattle-breeding operations have been directed along two lines:—

(1) The grading up of a country milk breed.

(2) Experiments in cross-breeding with imported bulls of high milking pedigree with the primary object of obtaining reliable information regarding the inheritance of observable characters of both breeds and of fixing, if possible, a new dairy breed of high milk yielding properties.

The Punjab Montgomery or Saniwal cattle are being used as a representative country milk breed for grading experiments and also as the female parent for cross-breeding. During the last 10 years by careful selection the average daily yield of the pure Montgomery herd has increased from 5½ to 9 lb. per cow (including dry periods as well as those in milk). Although only the progeny of poor milkers is used for cross-breeding, the average daily yield of the cross-bred cows amounted to 15 lb. during the year under review. The first batch of double-cross heifers is now in milk, and on their milking performances will largely depend the laying down of future lines of work. Two outstanding facts, both of great practical importance, have already emerged, *viz.*, the prepotency of the sire in milk production and the shortening of the dry period through weaning the calves from birth.

The cattle-breeding operations in the PUNJAB are in charge of the Veterinary Department whose policy is the preservation and improvement of the indigenous breeds of the province from the point of view of draft by a process of selection from amongst the best looking specimens procurable, a species of mass selection. By the very thorough application of this policy on the Hissar farm the Hissar breed has been established. Likewise for the Hariana, Dhanni and Montgomery breeds, schemes of improvement are in progress which are merely a duplicate, on a large scale, through sibsidizing private breeding operations in villages, of what has already been done on the Hissar farm.

The scheme for breeding Dhanni bulls which was started in 1918 had a very successful year on the return of normal

conditions after a lengthy period of fodder famine which prevailed in the tract. Forty-six bulls were at work in the three districts of Jhelum, Attock and Rawalpindi, and 4,220 coverings were recorded during the year. It is not possible to trace all the progeny of these bulls, but over 2,400 have been registered as now present within the tract. The experience gained in working this scheme points to the necessity for fodder conservation and the formation of reserve supplies for famine periods before much headway can be made, and the Punjab Veterinary Department is trying to interest co-operative societies in the creation of such reserves.

Two hundred and fifteen bulls were issued from the Hissar farm to the districts as against 239 in the preceding year. The total number of bulls in the province at stud rose to 1,537, there being 257 additions against 160 casualties.

A cattle-breeding expert to work under the Agricultural Department was recruited during the year, but he resigned within a few weeks of his arrival in the country and the proposed biometric cattle survey could not be taken up.

In the NORTH-WEST FRONTIER PROVINCE, 56 bulls belonging to local bodies were at stud during the year. The small herd of Awankari cattle at the Tarnab farm is making good progress, and there are now four stud bulls available for service. The young stock got by the first bull at stud on the farm are stated to be superior to those which came to Tarnab with the in-calf cows that founded the herd. There is already evidence that the Awankari breed will not deteriorate in quality while it may gain in weight and power on the irrigated tracts of the Peshawar District.

With the creation of the post of a Deputy Director for developing cattle-breeding operations, the two bull-rearing and breeding farms in the UNITED PROVINCES have been transferred to the Agricultural Department. The one at Manjha deals with the well-known local Kherigarh breed, while the herd at the other farm at Madhurikund in the Muttra District consists mainly of Hissar and Montgomery cattle. Eleven stud bulls were issued to district and municipal boards during the year, and it has been possible to meet the bulk of the further demand

for 70 animals. With the object of popularizing the stud bulls on the farms it is proposed to build small bull paddocks outside the farm gate, in which, at certain periods of the year, bulls will be kept for service of herds passing daily along the adjoining routes. Four bulls and stud buffaloes were taken round on a tour of some villages in the Muttra District as an experimental measure. The advantages of the scheme seemed to appear to the cattle-owners who requested that it should be repeated on a larger scale during rains.

Results obtained at the Rangpur cattle farm during the last ten years indicate that while considerable improvement can be effected by better methods of feeding and rearing *desi* cattle of BENGAL, but that much more rapid progress is possible by the crossing of the local cattle with bulls of good pedigree such as those from Hissar. Small herds of two other famous milking breeds, *viz.*, Red Sindhi and Montgomery (or Saniwal), have therefore been established at the Dacca and Chinsura farms, and their performances under local climatic conditions are being closely watched. Stud bulls of these three breeds will be placed on Government farms and their service will be available to the cow-keepers in the neighbourhood. In a characteristically rice province like Bengal, however, the introduction of outside blood has to be very carefully watched. Qualities such as the power of digesting straw, for example, become of primary importance in tracts where rice straw is the only available fodder. The figures for digestion obtained from recent work at Pusa for Bihar bred animals are vastly superior to any found in the records of other countries, and the danger of lowering the power of rice straw digestion is thus by no means negligible.

It has been definitely decided to make milk production the primary object of cattle-breeding operations in BIHAR AND ORISSA, and to keep cows to the limit of the local demand for milk on all the larger farms of the Agricultural Department. The herd at Sipaya has accordingly been reduced to 30 local cows and a Montgomery bull, while the herd at Kanke has been increased to 66 cows. The Sabour dairy has been placed on an economic basis by raising the price of milk and reducing the number of cattle. At Neterhat, the sale of pure *ghi* prepared

from buffalo milk was found uneconomical, but cream-cheese found a good market at remunerative prices in the Ranchi Mental Hospital. Altogether 41 bulls were maintained for stud purposes in districts.

The policy of keeping two distinct herds, one of pure Patna and the other of Patna-Bhutia cross-bred cattle, was continued at the Upper Shillong farm in ASSAM. The demand for bulls exceeds the supply but is confined mostly to tea garden managers. Government hope to be able to extend the breeding operations when financial conditions are more favourable.

The scheme for a large central stock-breeding farm in BURMA has been put on the shelf for the time being, but experiments in selection from local cattle are being started on the agricultural farms. The work is likely to extend over several years as no strictly pure Burmese breed seems to exist at present, and the only possible line of action is to collect young bulls and heifers from centres where there has been so far very little crossing with Indian cattle. A scheme for a large dairy farm on modern lines has been obtained from the Imperial Dairy Expert, but no budget provision is possible until 1923-24.

There are nine Government cattle-breeding and two dairy farms in the CENTRAL PROVINCES where herds of all the distinct breeds found in the province are being improved by selection and in some cases by crossing. On the three farms in Chhattisgarh, cows of the small local breed are being served by Malvi bulls with distinctly promising results, while the Gaolao, Umardha, Khamgaon and Malvi breeds represented on the other farms are being bred pure. A herd of cows of the Nimari breed has lately been purchased for the Khandwa farm; which will be mated with a Montgomery bull with the object of raising a good dual purpose animal. Similar experiments are in progress for some years on the Telinkheri and Nagpur dairy farms where the indigenous Gaolao cows are served by Montgomery and Ayrshire bulls respectively. The cross-bred bullocks are strong and serviceable draft animals, and the cross-bred cows give much more milk than any of the local breeds. The demand for cattle bred on these farms was keener than usual, and 243 animals were sold as against 172 in the previous year. It will

increase still further when the scheme for subsidizing owners who are willing to keep stud bulls materializes.

The cattle-breeding operations in BOMBAY are concentrated at the two farms at Chharodi in North Gujarat and Bankapur in the Southern Mahratta Country. The object is definitely to improve two breeds (namely, the Kankrej type for Gujarat and the Amrit Mahal of South India) and render them more suitable for the tracts for which they are adapted. These investigations have revealed a milking capacity in the Kankrej breed which was previously unsuspected, and there are now cows on the Chharodi farm which in milk production stand well with the best Indian milking breeds. The small herd of Sindhi cattle previously maintained at Mirpurkhas has been transferred to a new breeding farm to be conducted by the Veterinary Department. A Government committee has recently considered the whole question of cattle improvement in the presidency, and further lines of work will be laid down in the light of its recommendations.

The storage of fodder, whether *juar kadbi* (dried sorghum stalks) or grass, on a large scale and in portable form, in years of plenty is a very useful operation in a country affected with periodical famines and hence with large changes in price from year to year. The scheme initiated by Mr. Keatinge some years ago to create such reserves in the Bombay Deccan is working successfully. The Kopergaon depôt which supplied no less than 3½ lakhs of lb. of first class dry fodder during the 1920-21 famine has been replenished during the year, and a new centre is being created in the Dharwar District.

In MADRAS, the main lines of work aim at the production of a number of good type Ongole bulls for distribution with the object of the maintenance and improvement of the breed generally, the improvement of country buffaloes, and the improvement of the Madras milk supply.

The established breeding centres in the MYSORE State being unable to supply the large number of bulls required for grading up the draft cattle of the State, the Agricultural Department proposes to create a breeding herd of its own. The work in the Hebbal dairy has shown that a gradual improvement in

the milk yield of Mysore cattle can be brought about by selection, while at the Rayankere farm, both Amrit Mahal and Sindhi cows are being crossed with Holstein bulls imported from America.

In BARODA a dairy farm has been started with the object of building up a pedigree herd of Gir cattle.

(*b*) ***Sheep-breeding.*** The grading up of the *desi* sheep into an animal with wool and mutton properties although beset with many well recognized difficulties is, however, quite a feasible proposition. Climate and disease are the two factors which militate against the success of cross-breeding operations, but the results hitherto achieved are by no means discouraging.

The introduction of the Merino strain on the Government sheep runs in the UNITED PROVINCES has resulted in a decided improvement in the quality of the country wool. The best animal so far produced is the seven-eighth Merino cross the wool of which has realized during the year under review a price equal to that of pure Merino. A demand has grown up among private owners of flocks for cross-bred rams, and 37 of these were issued during 1921-22. A systematic survey of the districts where the best indigenous sheep are found has also been taken in hand.

Satisfactory progress is being made in extending the use of Merino rams for breeding purposes in the PUNJAB. Eighty-seven rams and 50 ewes bred on the Hissar farm were purchased by private individuals during the year, and these were sent to the Ferozepore, Ludhiana, Lahore, Shahpur, Attock, Rawalpindi, Hissar and Lahore Districts. The demand for ewes is more keen, as it also is for cows, but of course cannot be met as most of the females bred on the farm have to be kept for drifting into the farm flock. The problem of securing for the small owner the fair market value of his wool is being dealt with by starting co-operative sheep-breeding societies members of which will be in a position to deal direct with the mills. This is a really good subject for co-operative marketing, and the progress of four such societies started during the year with selected country-bred ewes and rams from the Hissar farm will be watched with interest.

In the NORTH-WEST FRONTIER PROVINCE, the cross-bred progeny from the local Hashtnagari ews and fat-tailed Pusht-i-Kuh rams from Mesopotamia on the Tarnab farm show a general improvement of both fleece and mutton. They also mature earlier and withstand the climatic changes as well as the local breeds.

The improvement in clip of wool resulting from crossing with Merino rams continues to be very striking in MYSORE. The half-bred Merinos gave during the year 2 lb. 6 oz. of wool of good quality compared with an average yield of 13 oz. of coarse wool from local ewes. Arrangements are being made to form a Sheep Breeders' Association in the Kolar District which should lead to organized and co-operative effort for the improvement of the sheep-breeding industry.

## CHAPTER IX.

## PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

A complete list of agricultural publications issued in India during the year under review is given in Appendix VII (page 140). Briefly summarized, those issued by the Imperial and Provincial Departments of Agriculture are as follows:—

***Imperial.*** Thirteen memoirs, 31 bulletins and two indigo publications were issued during the year by the Pusa Research Institute, while over 25 publications were in the press on the 30th June, 1922.

A steady rise in the demand for the "Agricultural Journal of India," which continued to be issued every two months, and the other publications of the Institute indicates a growing interest taken by the educated section of the community in agricultural matters.

***Provincial.*** The quarterly journal of the BENGAL department, which is issued both in English and Bengali, had a second successful year of existence. Several bulletins and leaflets on practical subjects were also issued.

In BOMBAY, in addition to the regular issues of "The Poona Agricultural College Magazine" and the vernacular journals of the agricultural associations, five leaflets were published, along with their vernacular versions, on tobacco, paddy, sugarcane, etc.

Five leaflets and four bulletins were brought out by the MADRAS department during the year. The leaflet on the coconut stem-bleeding disease was issued in five languages and some 22,200 copies were printed. "A Hand-book of some South Indian Grasses" by Rao Bahadur Rangachari and a second revised edition of the same author's "Manual of Elementary Botany for India" were also published during the year. Over a hundred thousand copies of the Villagers' Calendar for 1921-22 printed in English and in all the vernaculars of the presidency were distributed through the agency of the Publicity

Officer who was also supplied, for circulation, with a monthly digest of the operations of the department beginning with January 1922.

A scheme for the reorganization of the departmental journal is under the consideration of Government in the UNITED PROVINCES. No fresh bulletin was issued during the year, but the existing pamphlets and leaflets were brought up-to-date. The demand for these ran into many thousands. The two vernacular monthlies, (1) "Mufid-ul-Muzaran" in Urdu and (2) "Kisanupkarak" in Hindi, continued to be regularly published from Partabgarh.

In the CENTRAL PROVINCES, over 17,000 copies of Dr. Clouston's "Story of Rai Saheb Kaluram Kurmi" and "The Book of Lessons on Indian Agriculture" were sold up to the end of the year under review. The action of a few of the taluk associations who of their own accord bore the expenses of publishing leaflets prepared at their request is to be welcomed.

A series of short monthly notes on "What to see at the farms" has been started by the BURMA department to keep those interested in touch with the work on the farms. A bulletin on bee-keeping was issued, several leaflets were revised or rewritten as required, and articles on various activities of the department were contributed to "Burma's Progress."

In ASSAM, a leaflet in Bengali on the "head rot" disease in areca palms was published for distribution in Surma Valley.

## CHAPTER X.

## EXPENDITURE OF THE AGRICULTURAL DEPARTMENTS.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year ending the 31st March, 1922, was Rs. 9,65,956 as against Rs. 9,84,553 (including capital expenditure from a special grant of Rs. 2,52,000 but excluding expenditure of the Imperial Dairy Expert, Sugar Bureau and Indian Central Cotton Committee) during the previous year. The details are given below:—

| | Rs. |
|---|---|
| General expenditure of the Institute (including the office of the Agricultural Adviser and Director | 2,88,707 |
| Botanical Section | 59,759 |
| Chemical Section | 52,744 |
| Physiological Chemical Section | 24,818 |
| Bacteriological Section | 53,450 |
| Mycological Section | 48,783 |
| Entomological Section | 57,010 |
| Pathological Entomological Section | 16,135 |
| Agricultural Section | 1,19,181 |
| Protozoological Section | 19,217 |
| Indigo Research Section | 41,230 |
| Imperial Dairy Expert | 22,168 |
| Sugar Bureau | 33,163 |
| Indian Central Cotton Committee | 1,29,591 |
| TOTAL | 9,65,956 |

The expenditure on the working of the Imperial Bacteriological Laboratory at Muktesar during the period amounted to

Rs. 7,06,331 as against Rs. 6,58,409 in the previous year. The principal items were as follows :—

| | Rs. |
|---|---|
| Salaries and travelling allowance of officers and staff | 1,67,085 |
| Feed and upkeep of animals | 2,96,028 |
| Cost of chemicals and apparatus | 58,452 |
| Purchase of animals | 91,053 |
| Other miscellaneous expenditure | 93,713 |
| TOTAL | 7,06,331 |

The total expenditure incurred by the Provincial Departments of Agriculture during the year amounted to Rs. 1,04,78,701 as against Rs. 89,17,785 during 1920-21. The details are given below :—

| | Rs. |
|---|---|
| Bengal | 9,81,911 |
| Bihar and Orissa | 4,71,529 |
| United Provinces | 21,33,001 |
| Punjab | 16,72,072 |
| Bombay | 19,50,254 |
| Madras | 13,86,005 |
| Central Provinces | 9,55,800 |
| Burma | 5,22,615 |
| Assam | 3,21,099 |
| North-West Frontier Province | 55,954 |
| Baluchistan | 28,461 |
| TOTAL | 1,04,78,701 |

## APPENDIX I.

*Areas under new and improved varieties of crops during the year 1921-22.*

| Province | Name of crop | Area in acres | Advantages | Remarks |
|---|---|---|---|---|
| Bengal | Paddy (*Kataktara, Indrasail* and *Nagra*). | 56,286 | The yield is 3 to 6 maunds more per acre than the local varieties. | Areas shown here are mainly those sown with seed issued through departmental sources, but natural spread has been taken into consideration in few instances. |
| | Groundnut | 1,400 | Yielding handsome profits. | |
| | Wheat (Pusa 12) | 256 | Has good milling qualities. | |
| | Sugarcane (*Tanna*) | 978 | Yields 6 to 12 maunds of more *gur* per acre. | |
| | Jute (green *olitorius, Kakya Bombai*, R 85 and R 26) | 100,000 | Give finer quality and greater quantity of fibre than the local varieties. | |
| Bihar and Orissa | Groundnut | 431 | Suitable to be cultivated in waste lands and in comparatively poor soil at a small cost. | Increasing rapidly. |
| | Wheat (Pusa 12) | 505 | More prolific under irrigation and yields about 25 per cent. more than the local variety. | |
| | Sugarcane (*Mungo, Khari* and *Saretha*). | .. | .. | The area under these canes is spreading rapidly among cultivators. |
| | Paddy (*Dahia*) | 5,000 | .. | This paddy is spreading very rapidly of its own accord since its first introduction by the Agricultural Department. |
| | *Dhaincha* | 2,596 | .. | This is spreading rapidly of its own accord in Orissa where it was introduced by the Agricultural Department. |

*Areas under new and improved varieties of crops during the year 1921-22*—contd.

| Province | Name of crop | Area in acres | Advantages | Remarks |
|---|---|---|---|---|
| United Provinces | Wheat (Pusa 4, 12 and 110, Cawnpore 13). | 241,000 | Better yielders than local varieties. Less liable to be lodged and rusty than local varieties. | Areas shown here are mainly those sown with seed issued through departmental sources. The total area now under some of the improved varieties is, however, several times more. |
| | Cotton (Cawnpore—American, A. W. F., J N 1, K 22). | 78,120 | In yield, staple, and ginning percentage superior to local varieties. | |
| | Sugarcane (S 39, 42 and 48, Mauritius 16, A 42 and Reora). | 3,000 | Yield more *gur* than local varieties. | |
| | Barley . . . . | 24,000 | Better yielders than local varieties. | |
| | Gram . . . . | 12,000 | | |
| | Miscellaneous . . . | 24,000 | | |
| Punjab . . | Wheat— | | | |
| | Punjab 11 . . . | 749,966 | Yields more than local varieties. | |
| | 8A . . . . | 22,837 | Gives more outturn of grain and straw than even Punjab 11. | |
| | Cotton— | | | |
| | American 4F . . | 356,456 | Competes favourably with indigenous varieties where soil and water conditions are favourable. Has a finer staple and fetches higher price than *desi* cottons. | |
| | American 285F . . | 9,140 | Has a lint of $1\frac{1}{16}$ to $1\frac{1}{8}$ in. as compared with $\frac{15}{16}$ in. of 4F. It has also a shorter vegitative period. | |

| | | | | |
|---|---|---|---|---|
| Bombay | Cotton— | | | |
| | Selection I.A. | 9,898 | The lint is sold at a premium of Rs. 23 to Rs. 68 per candy of 784 lb. | Besides this controlled area, other area of about 13,000 acres was selected for collection and distribution of improved seed produced by cultivators. |
| | 1027 A.L.F. | | | |
| | Neglectum roseum | 6,000 | Gives an increased profit of Rs. 7 per acre over Khandesh mixture. | |
| | Dharwar Nos. 1 and 3 | 69,800 | Gives an increased profit of Rs. 4 to Rs. 11 per acre. | |
| | Gadag No. 1 | | | |
| | Punjab 4F | 3,000 | Prolific, early, hardy. Unginned cotton gets a premium of 12½ per cent. | |
| | Desi 27 W.N. | 200 | Gives a higher yield and a higher ginning percentage. Bright colour. | |
| | Groundnut | 89,525 | Gives an increased profit of Rs. 10 to Rs. 30 over the ordinary grain crops. | |
| | Sugarcane (Manjav and Red Mauritius) | 655 | Both are resistant to water-logged conditions. Manjav is an early ripener, while Red Mauritius yields more *gur*. | |
| | Bajra (Akola variety) | 13,000 | Gives an increased profit of 25 per cent. | |
| | Wheat (Pusa 4 and 12) | 500 | Better yielders than local varieties. | In addition, there are considerable areas under Pusa 12 in Sind of which the department has no record. |
| | Rice (various selected strains of *Kolamba*). | 76 | Better yielders. | |
| Madras | Paddy | 29,000 | Better yielders than local varieties and more profitable to cultivators. | |
| | Sugarcane | 19,000 | | |
| | Cotton | 385,000 | | |
| Central Provinces | Paddy | 61,768 | Gives an increased profit of Rs. 4 to Rs. 20 per acre over local varieties. | The areas given were sown with the seed distributed in the year under report, but the total area now under improved varieties is probably about three times the total for the year. |
| | Wheat | 40,599 | Gives an increased profit of Rs. 2 to Rs. 13 per acre over local varieties. | |

*Areas under new improved varieties of crops during the year 1921-22*—concld.

| Province | Name of crop | Area in acres | Advantages | Remarks |
|---|---|---|---|---|
| Central Provinces —*concld.* | Sugarcane | 120 | Gives an increased profit of Rs. 25 to Rs. 100 per acre over local varieties. | The areas given were sown with the seed distributed in the year under report, but the total area now under improved varieties is probably about three times the total for the year. |
| | Cotton | 248,836 | Gives an increased profit of Rs. 8 to Rs. 14 per acre over local varieties. | |
| | Groundnut | 3,840 | Gives a higher return of Rs. 15 to Rs. 20 per acre. | |
| | *Juar* | 30,780 | Gives a higher return of Rs. 5 to Rs. 10 per acre. | |
| | Other crops including *til* | 4,160 | Gives a higher return of Rs. 2 per acre. | |
| Burma | Paddy | 73,135 | Better yielders and more profitable to cultivators. | |
| | Cotton | 847 | | |
| | Sugarcane | 2,467 | | |
| | Wheat | 210 | | |
| | Groundnut | 2,152 | | |
| | Gram | 2,500 | | |
| Assam | Paddy | 4,184 | On an average gives increased outturn of 323 lb. per acre over local varieties. | |
| | Potatoes | 228 | Higher yielders than *desi* varieties. | |
| | Jute | 892 | | |
| | Sugarcane | 443 | | |
| North-West Frontier Province. | Wheat (Pusa 4) | 150,000 | Gives an increased profit of Rs. 10 to Rs 15 per acre over local varieties. | |

## APPENDIX II.

*List of Agricultural Stations in British India in 1921-22.*

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| | Pusa, Bihar | 650 | Overseer | Imperial Agriculturist, Agricultural Research Institute, Pusa. | Under the Imperial Department of Agriculture. |
| Bombay | Surat | 292 | Superintendent | Deputy Director of Agriculture, Gujarat, Surat. | |
| | Amalsad | 19 | Overseer | Ditto | |
| | Nadiad | 44 | Tobacco Breeder | Ditto | |
| | Broach | 24 | Superintendent | Ditto | |
| | Dohad | 57 | Ditto | Ditto | |
| | Dhulia | 28 | District Agricultural Overseer. | Deputy Director of Agriculture, North Central Division, Nasik. | |
| | Jalgaon | 214 | Superintendent | Ditto | |
| | Kopargaon | 115 | Ditto | Deputy Director of Agriculture, South Central Division, Poona. | Mainly a fodder farm for famine use. (A small portion is utilized as a sugarcane station.) |
| | Baramati | 21 | Ditto | Ditto | Sugarcane farm. |
| | Manjri | 62 | Ditto | Ditto | Sugarcane experimental station. |

*List of Agricultural Stations in British India in 1921-22*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bombay—*concld.* | Dharwar | 134 | Superintendent | Deputy Director of Agriculture, Southern Division, Dharwar. | |
| | Gadag | 50 | Ditto | Ditto | |
| | Gokak Canal | 62 | Ditto | Ditto | |
| | Tegur | 370 | Fieldman | Ditto | Cattle-breeding farms. |
| | Chharodi | 2,300 | Manager | Deputy Director of Agriculture for Animal Breeding, Poona. | Cattle-breeding farms. |
| | Bankapur | 112 | Ditto | Ditto | Cattle-breeding farms. |
| | Alibag | 72 | Superintendent | Deputy Director of Agriculture, Konkan, Ratnagiri. | |
| | Ratnagiri | 93 | Ditto | Ditto | |
| | Kumta | 184 | Ditto | Ditto | |
| | Karjat | 6 | Rice Specialist | Ditto | Rice research station. |
| | Karjat | 9 | Superintendent | Plant Breeding Expert, Poona. | Rice-breeding station. |
| | Mirpurkhas | 200 | Ditto | Deputy Director of Agriculture, Sind, Karachi. | Seed farm. |
| | Mirpurkhas | 60 | Ditto | Ditto | |
| | Sukkur | 30 | Ditto | Ditto | |

| | | | | | |
|---|---|---|---|---|---|
| | Larkana | 65 | Ditto | Ditto | |
| | Landhi | 24 | Ditto | Ditto | |
| | Jacobabad | 300 | Ditto | Ditto | |
| | Ganeshkhind, Kirkee | 80 | Ditto | Horticulturist to Government, Poona. | Agricultural and botanical station. Horticultural course is given here. |
| | Modi Bag, Poona | 14 | Ditto | Ditto | Teaching garden. |
| | Poona | 185 | Professor of Agriculture, Poona. | Professor of Agriculture, Poona Agricultural College. | Agricultural College farm. |
| | Kirkee | 362 | Manager | Ditto | Agricultural College dairy. |
| | Coimbatore | 450 +42 | Manager | Superintendent, Central Farm, Coimbatore. | Central farm attached to the Agricultural College. |
| | Samalkota | 57 | Ditto | Deputy Director of Agriculture, I Circle, Cocanada. | |
| | Anakapalle | 40 | Ditto | Ditto | |
| | Hagari | 224 | Ditto | Deputy Director of Agriculture, III Circle, Bellary. | |
| Madras | Bantanahal | 819 | Ditto | Ditto | Sheep and seed farm. |
| | Sirvel | 44 | Ditto | Ditto | |
| | Nandyal | 88 | Ditto | Ditto | |
| | Palur | 52 | Ditto | Deputy Director of Agriculture, IV Circle, St. Thomas's Mount. | |
| | Gudiyattam | 18 | Ditto | Ditto | Demonstration farm. |

*List of Agricultural Stations in British India in 1921-22*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Madras—*concld.* | Manganallur | 92 | Manager | Deputy Director of Agriculture, V Circle, Trichinopoly. | |
| | Koilpatti | 140 | Ditto | Deputy Director of Agriculture, VI Circle, Madura. | |
| | Kasargod | 55 | Ditto | Deputy Director of Agriculture, VII Circle, Tellicherry. | West Coast coconut station. |
| | Taliparamba | 85 | Ditto | Ditto | |
| | Anamalai | 40 | Ditto | Cotton Specialist, Agricultural College, Coimbatore. | Cotton farm. |
| | Tenmalai (Travancore) | 20 | Ditto | Deputy Director of Agriculture, Planting Districts, Coimbatore. | Rubber stations. |
| | Mooply (Cochin) | 20 | Ditto | | |
| | Sidapur (Coorg) | 19 | Ditto | | Coffee station. |
| | Peermade (Travancore) | 20 | Ditto | | Tea station. |
| | Chintaladevi | 850 | Ditto | Deputy Director of Agriculture for Live-stock, Madras. | Cattle farm. |
| | Nanjanad, The Nilgiris | 90 | Overseer | Curator, Government Botanic Gardens and Parks, Ootacamund. | Seed potato farm. |
| | Coonoor | ... | Curator | Ditto | Pomological station. |
| | Dacca | 354 | Superintendent | Deputy Director of Agriculture, Eastern Circle. | |
| | Mymensingh | 20 | Ditto | | |
| | Comilla | 20 | Ditto | | |
| | Barisal | 20 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| Bengal | Rajshahi | 63 | Ditto | Deputy Director of Agriculture, Northern Circle. | |
| | Rangpur | 333 | Ditto | | Cattle farm. |
| | Rangpur | 19 | Ditto | | Demonstration farm. |
| | Burirhat (Rangpur) | 52 | Ditto | | Tobacco farm. |
| | Bogra | 23 | Ditto | | |
| | Pabna | 20 | Ditto | | |
| | Chinsura | 194 | Ditto | Deputy Director of Agriculture, Burdwan Division. | |
| | Burdwan | 32 | Ditto | | |
| | Gosaba | 10 | Ditto | Deputy Director of Agriculture, Presidency Division. | Private farm under the supervision of the Agricultural Department. |
| | Barhampore | 45 | Ditto | | |
| | Kalimpong | 76 | Manager | Director of Agriculture, Bengal. | |
| | Berhampore | ... | Superintendent of Sericulture. | Deputy Director of Sericulture. | Sericultural research stations. |
| | Kurseong | ... | | | |
| | Kalimpong | ... | | | |
| Bihar and Orissa | Sabour | 190 | Manager | Professor of Agriculture. | Home farm attached to the Sabour College. |
| | Jamui | 39 | Overseer | | |
| | Ranchi (Kanke) | 140 | Assistant Director of Agriculture. | Deputy Director of Agriculture, Chota Nagpur Circle, Ranchi. | |
| | Neterhat | 193 | Inspector | | Potato farm. |

*List of Agricultural Stations in British India in 1921-22*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bihar and Orissa—*concld.* | Purulia | 52 | Inspector | Deputy Director of Agriculture, Chota Nagpur Circle, Ranchi. | |
| | Ramgarh | 43 | Overseer | | |
| | Sambalpur | 32 | Inspector | | |
| | Cuttack | 150 | Manager | Deputy Director of Agriculture, Orissa Circle, Cuttack. | |
| | Khurda | 31 | Overseer | | |
| | Balasore | 80 | Ditto | | |
| | Angul | 25 | Ditto | Deputy Commissioner, Angul. | Private demonstration farm under the supervision of the Deputy Director of Agriculture, Orissa Circle. |
| | Sipaya | 379 | Superintendent | ..... | Cattle-breeding farm and sugarcane station. |
| | Cawnpore | 58 | Superintendent | | |
| | Kalianpur (Cawnpore) | 263 | Overseer | | |
| | Orai (Jalaun) | 87 | Superintendent | | |
| | Atarra (Banda) | 171 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| United Provinces | Etawah | 50 | Ditto | Deputy Director of Agriculture, Central Circle, Cawnpore, and Divisional Superintendent of Agriculture. | |
| | Hardoi | 40 | Ditto | | |
| | Mainpuri | 52 | Ditto | | |
| | Jaitpur (Hamirpur) | 31 | Overseer | | |
| | Partabgarh | 90 | Superintendent | Deputy Director of Agriculture, Eastern Circle, Partabgarh. | |
| | Naugawan (Sultanpur) | 250 | Ditto | | |
| | Fyzabad | 206 | Ditto | | |
| | Benares | 78 | Ditto | Divisional Superintendent of Agriculture. | |
| | Aligarh | 88 | Ditto | Deputy Director of Agriculture, Western Circle, Aligarh, and Divisional Superintendent of Agriculture. | |
| | Nawabganj (Bareilly) | 119 | Inspector | | |
| | Muzaffarnagar | 109 | Superintendent | | |
| | Muttra | 56 | Inspector | | |
| | Agra | 100 | Ditto | | |
| | Saharanpur | 39 | Superintendent | | |
| | Bulandshahr | 25 | Inspector | | |
| | Aligarh (Kalai) | 142 | Superintendent | | |
| | Gorakhpur | 110 | Overseer | Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur. | |
| | Bahraich | 21 | Ditto | | |
| Punjab | Lyallpur | 614 | Manager | Deputy Director of Agriculture, 3rd Circle. | |
| | Montgomery | 250 | Extra Assistant Director of Agriculture. | Professor of Agriculture, Punjab Agricultural College. | Mainly a seed farm. |

*List of Agricultural Stations in British India in 1921-22*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Punjab—*concld.* | Gurdaspur | 161 | Manager | Deputy Director of Agriculture, 1st Circle. | Seed farms. |
| | Sargodha | 157 | Ditto | | |
| | Chillianwalla | 250 | Ditto | | |
| | Hansi | 200 | Ditto | Deputy Director of Agriculture, 2nd Circle. | |
| | Kahuta | 558 | Extra Assistant Director of Agriculture. | Agricultural Chemist, Punjab. | For reclamation of saline soils. |
| Burma | Mandalay | 601 | Superintendent | Deputy Director of Agriculture, Northern Circle. | |
| | Padu | 29 | Senior Agricultural Assistant. | | |
| | Nagu Plots | ½ | Junior Agricultural Assistant. | | |
| | Hopin | 33 | Ditto | | |
| | Yawnghwe | 36 | Superintendent | | |
| | Tatkon | 45 | Ditto | | |
| | Hmawbi | 432 | Ditto | | |
| | Nyaunglebin (Pegu) | 15 | Junior Agricultural Assistant. | Deputy Director of Agriculture, Southern Circle. | |
| | Yedashe (Toungoo) | 27 | Ditto | | |
| | Zigon (Tharrawaddy) | 20 | Ditto | | |
| | Thilawa (Hanthawaddy) | 53 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| | Pwinbyu (Mimbu) | 22 | Ditto | Deputy Director of Agriculture, West Central Circle. | |
| | Allanmyo (Thayetmyo) | 143 | Senior Agricultural Assistant. | | |
| | Taungtha (Myingyan) | 16 | Junior Agricultural Assistant. | Deputy Director of Agriculture, Myingyan Circle. | Rented temporarily. |
| | Pakokku | 25 | Ditto | | |
| | Mahlaing (Meiktila) | 248 | Superintendent | | |
| | Nagpur | 268 | Ditto | Principal, Agricultural College, Nagpur. | College farm. |
| | Akola | 271 | Ditto | Economic Botanist, Nagpur. | |
| | Borgaon | 368 | Ditto | Deputy Director of Agriculture, Western Circle, Amraoti. | |
| | Yeotmal | 106 | Ditto | | |
| | Khandwa | 177 | Ditto | | |
| | Basim | 109 | Ditto | | |
| Central Provinces | Sindewahi | 197 | Ditto | Deputy Director of Agriculture, Southern Circle, Nagpur. | |
| | Tharsa | 116 | Ditto | | |
| | Wara-Seoni | 63 | Ditto | | |
| | Telinkheri | 1,000 | Ditto | | Dairy farm. |
| | Chandkhuri | 333 | Ditto | Deputy Director of Agriculture, Eastern Circle, Raipur. | |
| | Bilaspur | 253 | Ditto | | |
| | Drug | 281 | Ditto | | |
| | Raipur | 229 | Ditto | | |

*List of Agricultural Stations in British India during 1921-22*—concld.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Central Provinces —*concld.* | Powarkhera (Hoshangabad). | 528 | Superintendent | Assistant Director of Agriculture, Chhindwara. | |
| | Seoni | 164 | Ditto | | |
| | Chhindwara | 69 | Ditto | | |
| | Betul | 161 | Ditto | | |
| | Adhartal (Jubbulpore) | 637 | Ditto | Deputy Director of Agriculture, Northern Circle, Jubbulpore. | |
| | Saugor | 161 | Ditto | | |
| | Damoh | 152 | Ditto | | |
| Assam | Jorhat | 59 | Manager | Deputy Director of Agriculture, Assam Valley. | Sugarcane station. |
| | Upper-Shillong | 367 | Ditto | Deputy Director of Agriculture, Surma Valley and Hill Districts. | Potato station |
| | Karimganj | 80 | Ditto | | Rice station. |
| North-West Frontier Province. | Tarnab (Peshawar) | 200 | Manager | Agricultural Officer, North-West Frontier Province, Peshawar. | |
| | Haripur | 20 | Ditto | | |

## APPENDIX III.

*List of Agricultural Colleges and Schools in British India during 1921-22.*

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | *(a) Post-graduate Training Institution.* | | | |
| ... | Agricultural College, Pusa | Pusa, Bihar | 12 | Besides regular courses in Botany, Mycology, Agricultural Chemistry, Agricultural Bacteriology, Entomology, and General Agriculture, short courses in Sericulture and Lac-culture are also given. | |
| | | *(b) Provincial Agricultural Colleges.* | | | |
| Bombay | Poona Agricultural College | Poona | 205 | Affiliated to the University of Bombay who confers the Degree of B.Ag. on passed students. The course is for 3 years. Students before admission must have passed the Previous Examination of the Bombay University or Intermediate Examination in Arts or in Science of any other Indian University or of the London University.<br><br>A short course in agriculture is also given to farmers' sons | |

*List of Agricultural Colleges and Schools in British India during 1921-22*—contd.

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | | | (*b*) *Provincial Agricultural Colleges*—concld. | |
| | | | | who know English but who are not qualified to take the University course in agriculture. This course lasts for 1 year. | |
| Madras | Agricultural College, Coimbatore. | Coimbatore | 100 | Three courses of instruction are given :—<br>(1) The first course (2 years) for the Certificate of Proficiency in practical agriculture.<br>(2) The second course (18 months in continuation of the first course) for the Diploma or Licentiate in Agriculture.<br>(3) New Diploma course (3 years)—this is eventually to replace No. (2) above. | |
| Central Provinces | Agricultural College, Nagpur. | Nagpur | 52 | The courses of instruction given are :—<br>(1) Three and half years' Diploma course for the Licentiate of Agriculture, and<br>(2) Two years' certificate course for the sons of malguzars and substantial cultivators who intend to manage their own lands, and to | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | whom a full scientific course is unnecessary. | |
| Bihar and Orissa | Agricultural College, Sabour. | Sabour (near Bhagalpur) | 25 | The course of instruction given is one of two years' Certificate. Besides this, short season courses (*Bhadoi* and *Rabi*) are given. | As it has been decided to close the college in March 1923, no new student has been admitted in the first year class in the session 1922-23. |
| United Provinces | Agricultural College, Cawnpore. | Cawnpore | 103 | Two courses of instruction are given :—<br>(1) Diploma (L.Ag.) course of 4 years, and<br>(2) Two years' or Vernacular course. | |
| Punjab | Punjab Agricultural College. | Lyallpur | 198 | Affiliated to the Punjab University. Two courses of instruction are given :—<br>(1) Two years' course for Leaving Certificate ; and<br>(2) Four years' course for the Degree of B.Sc. in Agriculture. Besides, there are : a Vernacular Class which lasts for 1 year only, a Teachers' class which lasts for one year and a Rural Economy class which lasts for a shorter period. | |
| | | (c) *Agricultural High and Middle Schools.* | | | |
| Central Provinces. | Agricultural Middle School, Powarkhera. | Powarkhera Experimental Farm, District Hoshangabad. | 6 | 2 years' course. | |
| | Agricultural Middle School, Chandkhuri. | Chandkhuri Experimental Farm, District Raipur. | 18 | 2 years' course. | |

*List of Agricultural Colleges and Schools in British India during 1921-22*—concld.

| Province | Name of College or School | Location of College or School | Number of Students on the Roll | Courses of instruction | Remarks |
|---|---|---|---|---|---|
| | | (c) *Agricultural High and Middle Schools*—concld. | | | |
| Bengal | Amarpur Middle English School. | Amarpur, District Burdwan. | 36 | Standard V and VI students are taught agriculture, both theoretical and practical, for six days in the week for one hour daily. | Both of these schools are mainly financed by local effort. |
| | Durgapur High English School. | Durgapur, District Chittagong. | 55 | Students of classes VII and VIII are given training in agriculture, both theoretical and practical. | |
| | | (d) *Vernacular Agricultural Schools.* | | | |
| Bombay | Vernacular Agricultural School, Loni (in Marathi). | Loni, District Poona | 46 | 2 years' course. | |
| | Vernacular Agricultural School, Devi-hosur (in Kanarese). | Devi-hosur, District Dharwar. | 26 | 2 years' course. | |
| | Vernacular Agricultural School, Veshvi, Kolaba (in Marathi). | Veshvi, District Kolaba. | 12 | 2 years' course. | |
| | Vernacular Agricultural School, Jambul (in Marathi). | Jambul, District Thana. | 29 | 2 years' course. | |
| | Vernacular Agricultural School, Godhra (in Gujarati). | Godhra, District Panch-mahals. | 31 | 2 years' course. | |

| | | | | | |
|---|---|---|---|---|---|
| | Vernacular Agricultural School, Sukkur (in Sindhi). | Sukkur, Sind. | 12 | 1 year's course. | |
| Bengal | Secondary Agricultural School, Dacca. | Dacca Central Farm | 29 | The new curriculum includes agriculture, rural engineering, veterinary hygiene, book-keeping and rural economics. | A stipend of Rs. 10 per mensem is allowed for each pupil to meet feeding expenses. |
| | Secondary Agricultural School, Chinsura. | Chinsura Agricultural Farm, District Hooghly. | 35 | | |
| Madras | Agricultural Middle School, Taliparamba. | Taliparamba | 18 | ... | |
| | Agricultural Middle School, Anakapalle. | Anakapalle | 6 | ... | |
| United Provinces | Vernacular Agricultural School, Bulandshahr. | Balundshahr | 31 | Two years' or Vernacular course. | |
| Bihar and Orissa | Vernacular Agricultural School on Lower Primary basis attached to the C. M. S. Mission Upper Primary School. | Pathra (Godda), District Santal Parganas. | 59 | Practical training is given in cotton growing, rice cultivation, maize cultivation and gardening. | Receives a monthly grant of Rs. 30. |

## APPENDIX IV.

### *Operations of Non-Credit Agricultural Co-operative Societies in British India during 1921-22.*

The two tables below include Agricultural Societies for—

A. 1. *Purchase, and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.

4. Other forms of co-operation except insurance.

Insurance.

*Operations of Non-Credit Agricultural Co-operative Societies in British India during 1921-22*—contd.

(A) *Purchase, Sale and Production.*

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bombay | Purchase and Purchase and Sale. | 90 | 3,852 | 71,638 | 24,904 | 1,56,713 | +4,262 | |
| | Production | 24 | 626 | 24 | ... | 9,698 | +66 | |
| | Production and Sale | 39 | 5,142 | 1,68,363 | 4,06,205 | 1,90,308 | +20,375 | |
| | Others | 1 | 20 | ... | ... | 15,131 | —55 | |
| | TOTAL | 154 | 9,640 | 2,40,025 | 4,31,109 | 3,71,850 | +24,648 | |
| Madras | Purchase and Purchase and Sale. | 75 | 6,233 | 2,53,630 | 1,88,842 | 3,41,132 | +14,039 | |
| | Production and Sale | 4 | 207 | 1,016 | ... | 76,500 | +1,697 | |
| | Others | 4 | 290 | ... | ... | 7,395 | +134 | |
| | TOTAL | 83 | 6,730 | 2,54,646 | 1,88,842 | 4,25,027 | +15,870 | |
| Bengal | Purchase and Purchase and Sale. | 15 | 3,834 | 1,45,915 | 7,600 | 1,36,214 | —326 | |
| | Production | 29 | 1,318 | ... | ... | 42,626 | +54 | |
| | Production and Sale | 50 | 5,512 | 9,97,624 | 7,13,754 | 6,18,215 | +3,48,314 | |
| | Others | 5 | 50 | ... | ... | 250 | —37 | |
| | TOTAL | 99 | 10,714 | 11,43,539 | 7,21,354 | 7,97,305 | +3,48,005 | |

*Operations of Non-Credit Agricultural Co-operative Societies in British India during 1921-22*—concld.

(A) *Purchase, Sale and Production*—concld.

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bihar and Orissa | Purchase and Purchase and Sale. | 7 | 170 | 5,957 | ... | 2,956 | +296 | |
| | Production and Sale . . | 26 | 326 | 8,024 | 3,245 | 22,981 | —4,622 | |
| | TOTAL . | 33 | 496 | 13,981 | 3,245 | 25,937 | —4,326 | |
| United Provinces | Purchase and Purchase and Sale. | 1 | 73 | ... | 2,063 | 6,893 | —21 | |
| | Production . | 1 | 55 | ... | ... | 1,636 | —23 | |
| | Production and Sale . . | 7 | 275 | ... | 7,009 | 27,229 | +110 | |
| | TOTAL . | 9 | 403 | ... | 9,072 | 35,758 | +66 | |
| Punjab | Purchase and Purchase and Sale. | 160 | 1,175+1,759* | 1,72,284 | 22,858 | 3,12,915 | —17,689 | Societies |
| | Production and Sale . . | 11 | 477+276* | 3,91,692 | 4,05,498 | 2,77,925 | —212 | |
| | Others . . . . . | 352 | 22,179+8* | ... | ... | 3,826 | +694 | |
| | TOTAL . | 523 | 23,831+2,043* | 5,63,976 | 4,28,356 | 5,94,666 | —17,207 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Burma | Purchase and Purchase and Sale. | 17 | 959 | 19,554 | ... | 18,422 | —2,034 |
| | Production | 2 | 130 | ... | ... | ... | ... |
| | Production and Sale | 67 | 6,517 | 4,43,263 | 4,99,340 | 6,52,731 | +14,942 |
| | Others | 41 | 861 | ... | ... | ... | ... |
| | TOTAL | 127 | 8,467 | 4,62,817 | 4,99,340 | 6,71,153 | +12,908 |
| Central Provinces and Berar. | Purchase and Purchase and Sale. | 6 | 386 | 10,649 | 1,388 | 19,995 | +2,166 |
| | Production | 25 | 244 | 530 | 350 | 1,043 | +378 |
| | Production and Sale | 1 | 143 | ... | ... | 9,912 | +963 |
| | TOTAL | 32 | 873 | 11,179 | 1,738 | 30,950 | +3,507 |

## (B) *Cattle Insurance.*

| PROVINCE | Number of societies | Amount of risk insured | Premia collected during the year | Supplementary contribution collected | NUMBER OF ANIMALS | | Claims paid | Cost of management | Funds in hand at end of year | Amount of risk re-insured | Amount of premia paid for re-insurance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Insured | Lost | | | | | |
| | | Rs. | Rs. | Rs. | | | Rs. | Rs. | Rs. | Rs. | Rs. |
| Bombay | 9 | 12,060 | 608 | ... | 188 | 3 | 100 | 143 | 958 | ... | ... |
| Punjab | 41 | 59,383 | 3,033 | 156 | 560 | 6 | 381 | 41 | 6,185 | 5,805 | 223 |
| | 1* | 5,445 | 214 | ... | 119 | 1 | 33 | ... | 1,059 | ... | ... |
| Burma | 383 | 1,34,964 | 3,957 | ... | 3,056 | 79 | 2,509 | 291 | 36,712 | 64,703 | 1,928 |
| | 1* | 64,703 | 1,751 | ... | 2,720 | 79 | 978 | 1,128 | 14,913 | ... | ... |
| United Provinces | 1 | 1,308 | 20 | ... | 24 | ... | ... | ... | 24 | ... | ... |

* Central Re-insurance Society.

## APPENDIX V.

*Table showing the working of the Provincial Civil Veterinary Departments during 1921-22.*

| Province | No. of Superior staff | | Research | Dispensaries and Hospitals | | | District staff and work | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Imperial Service Officers | Provincial Service Officers | | No. of Hospitals and Dispensaries | No. of Veterinary Assistants employed | No. of cases treated and castrations performed | No. of Inspectors | No. of Veterinary Assistants | Cases treated and castrations performed | No. of outbreaks in which inoculation was undertaken | Deaths uninoculated | Inoculations | Deaths after inoculation |
| Bombay | 4 | 8 | Parasitic infection, examination of specimens, etc. | 80 | 80 | 166,994 | 5 | 80 | 48,240 | 394 | 5,004 | 39,549 | 200 |
| Madras | 5 | 6 | Examination of specimens, etc. | 64 | 64 | 92,741 | 16 | 64 | 49,646 | 488 | 9,919 | 70,815 | 196 |
| Bengal | 3 | 8 | Do. do. | 39 | 40 | 46,705 | 8 | 84 | 67,511 | 522 | 8,803 | 78,673 | 408 |
| Bihar and Orissa | 3 | 2 | Do. do. | 23 | 23 | 36,316 | 10 | 81 | 40,824 | 967 | 7,818 | 123,387 | 667 |
| United Provinces | 3 | 4 | Do. do. | 117 | 117 | 167,883 | 18 | 120 | 60,754 | 359 | 4,079 | 39,648 | 30 |
| Punjab | 10 | 10 | Do. do. | 159 | 162 | 431,168 | 19 | 172 | 433,612 | 1,152 | 11,944 | 226,109 | 209 |
| Burma | 4 | 6 | Do. do. | 4 | 4 | 4,070 | 24 | 225 | 119,558 | 395 | 1,612 | 31,980 | 76 |
| Central Provinces | 2 | 3 | Bovine trypanosomiasis, piroplasmosis, infection by gastro-worm, examination of specimens, etc. | 53 | 53 | 204,316 | 10 | 106 | 462,785 | 312 | 2,845 | 28,695 | 206 |
| Assam | 1 | 1 | Examination of specimens, etc. | 3 | 3 | 6,235 | 3 | 44 | 61,759 | 317 | 5,629 | 24,012 | 309 |
| North-West Frontier Province | ... | ... | Do. do. | 10 | 10 | 50,723 | 5 | 10 | 10,531 | 108 | 1,210 | 35,673 | 39 |
| Sind | 1 | 1 | Do. do. | 16 | 16 | 23,500 | ... | 16 | 4,759 | 214 | 5,121 | 16,339 | 127 |
| Baluchistan | | ... | Do. do. | 6 | 6 | 10,677 | 1 | 6 | 644 | 2 | 13 | 541 | ... |
| Rajputana | | ... | Do. do. | 2 | 2 | 1,693 | ... | 3 | 2,361 | 1 | 26 | 400 | ... |
| Total for 1921-22 | 36 | 49 | | 616 | 619 | 1,242,751 | 125 | 1,030 | 768,954 | 5,191 | 63,023 | 745,094 | 2,367 |
| Total for 1920-21 | 35 | 47 | | 574 | 576 | 1,096,834 | 125 | 978 | 676,131 | 6,866 | 88,778 | 856,552 | 3,789 |

## APPENDIX VI.

*Table showing the details as to Students of Veterinary Colleges and Schools in India during 1921-22.*

| Veterinary College or School | Course of instruction | Number of students | | | | | | Students admitted during the year, classed by educational qualifications | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Admitted during the year | | Passed final examination during the year | Failed to pass final examination | Remaining under instruction at end of the year | | Matriculates, school finals or with higher qualifications | Knowing some English but not matriculates | Knowing no English or very little English |
| | | Scholarship-holders | Others | | | In ordinary course | Instruction prolonged by reason of failure to pass | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Bombay Veterinary College | 3 years' English course. | 18 | 12 | 19 | 8 | 28 | 10 | 8 | 22 | ... |
| Madras „ „ | Do. | 37 | 1 | 22 | 8 | 44 | 27 | 38 | ... | ... |
| Bengal „ „ | Do. | 37 | 24 | 36 | 8 | 80 | 20 | 32 | 29 | ... |
| Punjab „ „ | 3 years' Vernacular course. | ... | ... | 72 | 11 | 65 | 20 | ... | ... | ... |
| | 4 years' English course. | 4 | 25 | ... | ... | 19 | ... | 28 | 1 | ... |
| Insein Veterinary School | 3 years' Vernacular course. | 16 | ... | 15 | ... | 40 | ... | ... | ... | 16 |

## APPENDIX VII.

*List of Agricultural Publications in India during 1921-22.*

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** | | |
| 1 | The *Agricultural Journal of India*, Vol. XVI, Parts IV, V and VI, and Vol. XVII, Parts I, II and III. Price R. 1-8 or 2*s.* per part; annual subscription R. 6 or 9*s.* 6*d.* | Edited by the Agricultural Adviser to the Government of India, Pusa. | Messrs. Thacker, Spink and Co., Calcutta. |
| 2 | Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert and the Secretary, Sugar Bureau) for 1920-21. Price R. 1-8. | Issued from the Agricultural Research Institute, Pusa. | Government Printing, India, Calcutta. |
| 3 | Review of Agricultural Operations in India, 1920-21. Price R. 1-4. | Agricultural Adviser to the Government of India, Pusa. | Ditto |
| 4 | Proceedings of the Board of Agriculture in India held at Pusa on the 13th February, 1922, and the following days (with appendices). Price R. 1. | Ditto | Ditto |
| 5 | Experiments with Castor Seed conducted at Sabour. Pusa Agricultural Research Institute Bulletin No. 117. Price As. 3. | C. Somers Taylor, B.A., Agricultural Chemist, Bihar and Orissa. | Ditto |
| 6 | The Agricultural Development of Baluchistan. Pusa Agricultural Research Institute Bulletin No 119. Price As. 6. | Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist. | Ditto |
| 7 | Pusa 12 and Pusa 4 in the Central Circle of the United Provinces. Pusa Agricultural Research Institute Bulletin No. 122. Price As. 11. | B. C. Burt, M.B.E., B.SC., F.C.S., Deputy Director of Agriculture, Central Circle, United Provinces, Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 8 | The Bundelkhand Cottons Experiments in their Improvement by Pure Line Selection. Pusa Agricultural Research Institute Bulletin No. 123. Price As. 4. | B. C. Burt, M.B.E., B.SC., F.C.S., Deputy Director of Agriculture, Central Circle, United Provinces, and Nizamuddin Hyder, Subordinate Agricultural Service, United Provinces. | Government Printing India, Calcutta. |
| 9 | Safflower Oil. Pusa Agricultural Research Institute Bulletin No. 124. Price As. 4. | Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and J. Stewart Remington, Consulting Chemist, Aynsome Technical Laboratories, Grange-over-Sands, Lancashire. | Ditto |
| 10 | Cawnpore-American Cotton, II: Further Field Trials (1918-20), Spinning Trials and Market Organization. Pusa Agricultural Research Institute Bulletin No. 126. Price As. 4. | B. C. Burt, M.B.E., B.SC., Secretary, Indian Central Cotton Committee. | Ditto |
| 11 | Annual Report of the Board of Scientific Advice for India for 1920-21. Price As. 12. | Issued by the Board of Scientific Advice for India. | Ditto |
| 12 | Prices and Wages in India (thirty-sixth issue). Price Rs. 2. | Issued by the Department of Statistics, India. | Ditto |
| 13 | Estimates of Area and Yield of Principal Crops in India, 1920-21. Price As. 8. | Ditto | Ditto |
| 14 | Summary of Tables showing the total area, area cultivated and uncultivated, area under irrigation, and area under different crops, in British India in the agricultural year 1920-21. Price As. 4. | Ditto | Ditto |
| 15 | Estimates of Principal Crops in India, 1920-21. Price one-half anna. | Ditto | Ditto |
| 16 | Agricultural Statistics of British India, 1919-20, Vol. I. Price Rs. 2-8. | Ditto | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 17 | Agricultural Statistics of British India, 1919-20, Vol. II. Price R. 1-8. | Issued by the Department of Statistics, India. | Government Printing, India, Calcutta. |
| 18 | Agricultural Statistics of Bengal for 1920-21. Price Rs. 2. | Government of Bengal, Agriculture and Industries Department. | Bengal Secretariat Book Depôt, Calcutta. |
| 19 | Report on the Operations of the Department of Agriculture, Bengal, for the year 1920-21. Price Rs. 2-4. | Issued by the Department of Agriculture, Bengal. | Ditto |
| 20 | Season and Crop Report of Bengal for 1921-22. Price Rs. 2. | Ditto | Ditto |
| 21 | Proceedings of the Second Annual Conference of the Board of Agricultural Department, Bengal, held at Dacca, on the 1st and 2nd August, 1921 (for official use only). | Ditto | Ditto |
| 22 | A Note on Cotton (in English and Bengali). | D. Dutt, Offg. Second Economic Botanist to the Government of Bengal. | Ditto |
| 23 | Departmental Activities in Northern Bengal. | J. N. Sarkar, Offg. Deputy Director of Agriculture, Northern Circle, Bengal. | Ditto |
| 24 | A Note on Jute seed . . | Ditto | Ditto |
| 25 | Jute in Bengal (New Edition). . | Nibaran Chandra Chowdhury, M.R.A.S. | Messrs. W. Newman & Co., Calcutta. |
| 26 | *Bengal Agricultural Journal* (Quarterly). (In English and Bengali). Annual subscription R. 1-4; single copy As. 5. | Issued by the Department of Agriculture, Bengal. | Sreenath Press, Dacca. |
| 27 | Annual Report of the Department of Agriculture, Bihar and Orissa, for the year ending 30th June 1921. Price As. 8. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Printing, Bihar and Orissa, Patna. |
| 28 | Season and Crop Report of Bihar and Orissa for 1921-22. Price R. 1. | Ditto | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 29 | Agricultural Statistics of Bihar and Orissa for 1920-21. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Printing, Bihar and Orissa, Patna. |
| 30 | Report on the Administration of the Agricultural Department of the United Provinces of Agra and Oudh for the year ending 30th June, 1921. Price R. 1-2. | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 31 | Season and Crop Report of the United Provinces of Agra and Oudh for 1920-21. Price As. 12. | Issued by the Department of Land Records, United Provinces. | Ditto |
| 32 | Report on the Agricultural Stations of the Western Circle, United Provinces, for the year ending 31st May, 1921. Price R. 1-10. | Issued by the Department of Agriculture, United Provinces. | Ditto |
| 33 | Report on the Agricultural Stations in the Central Circle, United Provinces, for the year ending 30th June, 1921. Price R. 1. | Ditto | Ditto |
| 34 | Report on the Agricultural Stations in the North-Eastern Circle, United Provinces, for the year ending 30th June, 1921. Price As. 4. | Ditto | Ditto |
| 35 | Report on the Agricultural Stations in the Eastern Circle, United Provinces, for the year ending 30th June, 1921. Price As. 14. | Ditto | Ditto |
| 36 | Report on Government Botanical Gardens, United Provinces, Saharanpur, for the year ending 31st March, 1921. | Ditto | Ditto |
| 37 | Report on Government Horticultural Gardens, United Provinces, Lucknow, for the year ending 31st March, 1921. Price As. 3. | Ditto | Ditto |
| 38 | Annual Report of the Kumaun Government Gardens for the year 1920-21. Price As. 4. | Commissioner of Kumaun Division. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 39 | Annual Report of the Chaubattia and Sitoli Orchards for the year 1920-21. Price As. 4. | Commissioner of Kumaun Division. | Government Press, United Provinces, Allahabad. |
| 40 | Report on the operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1921, Part I. Price As. 8. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore |
| 41 | Report on the operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1921, Part II. (Annual Experiment Record.) Price Rs. 2-12. | Ditto | Ditto |
| 42 | Season and Crop Report of the Punjab for the year 1920-21. Price R. 1-6. | Ditto | Ditto |
| 43 | Tables of the Agricultural Statistics of the Punjab for the year 1920-21 | Ditto | Ditto |
| 44 | Annual Report of the Lawrence Gardens, Lahore, for 1920-21. Price As. 2. | Ditto | Ditto |
| 45 | Prospectus of the Punjab Agricultural College, Lyallpur (not for sale). | Ditto | Ditto |
| 46 | Report on the Failure of the Cotton Crop in 1919. Price R. 13-8. | D. Milne, B.SC., Economic Botanist, Punjab. | Ditto |
| 47 | Report on the Cotton survey of the Multan district. | Harnam Singh, L.AG., Agricultural Assistant, Lyallpur. | Ditto |
| 48 | Text-Book of Punjab Agriculture. | W. Roberts, B.SC., and O. T. Faulkner, B.A. | Civil and Military Press, Lahore. |
| 49 | Annual Report of the Department of Agriculture, Bombay Presidency, for 1920-21. | Issued by the Department of Agriculture, Bombay. | Yeravda Prison Press, Poona. |
| 50 | Season and Crop Report of the Bombay Presidency for 1920-21. Price *As.* 9-6. | Ditto | Government Central Press, Bombay. |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 51 | Triennial Report of the Experimental work of the Agricultural Station, Landhi, for the years 1918-19, 1919-20 and 1920-21. Price As. 4. | Issued by the Department of Agriculture, Bombay. | Yeravda Prison Press, Poona. |
| 52 | Triennial Report of the Experimental work of the Agricultural Station, Mirpurkhas, for the years 1918-19, 1919-20 and 1920-21 Price As 5. | Ditto | Ditto |
| 53 | Triennial Report of the Experimental work of the Agricultural Station, Larkana, for the years 1918-19, 1919-20 and 1920-21. Price As. 3. | Ditto | Ditto |
| 54 | Triennial Report of the Experimental work of the Agricultural Station, Sukkur, for the years 1918-19, 1919-20 and 1920-21. Price As. 5. | Ditto | Ditto |
| 55 | Report of the Experimental work of the Ratnagiri Agricultural Station for 4 years 1916-17 to 1919-20. Price As. 11. | Ditto | Ditto |
| 56 | Report of the Experimental work of the Kumta Agricultural Station for the 3 years 1917-18 to 1919-20. Price As. 5. | Ditto | Ditto |
| 57 | Report of the Experimental work of the Ganeshkhind Botanical Garden, Kirkee, for the years 1916-20. Price As. 2. | Ditto | Ditto |
| 58 | Rice cultivation in the Larkana District, Sind. Bombay Department of Agriculture Bulletin No. 99. Price As. 8. | Abdul Rahman Ishaq, L. AG., Acting Divisional Superintendent of Agriculture, Sind. | Government Central Press, Bombay. |
| 59 | Fodder Crops of Western India. Bombay Department of Agriculture Bulletin No. 100. Price Rs. 2-1. | Harold H. Mann, D.SC., Acting Director of Agriculture, Bombay Presidency, Poona. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 60 | Fruit culture in Palitana and Jamnagar. Bombay Department of Agriculture Bulletin No. 101. Price As. 8-6. | G. B. Patwardhan, B.SC., F.R.H.S., Assistant Professor of Botany, Agricultural College, Poona. | Government Central Press, Bombay. |
| 61 | Investigations on Potato cultivation in Western India. Bombay Department of Agriculture Bulletin No. 102. Price R. 1-15. | H. H. Mann, D.SC., S. D. Nagpurkar, B.AG., G. S. Kulkarni, M.AG., R. S. Kasargode, L.AG., S. R. Paranjpe, M.AG., and H. M. Joshi, B.SC. | Ditto |
| 62 | Book of Mango. Bombay Department of Agriculture Bulletin No. 103. Price Rs. 3-5. | W. Burns, D.SC. (Edin.), Economic Botanist to the Government of Bombay, and S. H. Prayag, M.AG. (Bombay), Department of Agriculture, Bombay. | Ditto |
| 63 | Ganeshkhind Botanical Garden, Kirkee. (Its Genesis and Development.) Bombay Department of Agriculture Bulletin No. 104. Price As. 15-6. | S. H. Prayag, M.AG. (Bombay), Department of Agriculture, Bombay. | Ditto |
| 64 | Dharwar-American Cotton, its history, cultivation and improvement. Bombay Department of Agriculture Bulletin No. 106. Price As. 7. | G. L. Kottur, B.AG., Cotton Supervisor, Dharwar. | Yeravda Prison Press, Poona. |
| 65 | Gonag: A Weed in Drilled Paddy. Bombay Department of Agriculture Bulletin No. 107. Price As. 5. | S. S. Salimath, B.AG., Inspector of Agriculture, Dharwar. | Ditto |
| 66 | Summary of the work done at Jalgaon Farm. Bombay Department of Agriculture Bulletin No. 108. Price As. 5-6. | P. C. Patil, L.AG., Deputy Director of Agriculture, Central Division. | Ditto |
| 67 | Summary of the work done on Jalgaon Farm. Bombay Department of Agriculture Bulletin No. 108 (in Marathi). Price As. 2½. | Ditto | Ditto |
| 68 | Tobacco—A profitable new crop for Kanara District. Bombay Department of Agriculture Leaflet No. 5 of 1921. | Issued by the Department of Agriculture, Bombay. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 69 | Green manuring of "Nagli" with "San." Bombay Department of Agriculture Leaflet No. 2 of 1922. | Issued by the Department of Agriculture, Bombay. | Yeravda Prison Press, Poona. |
| 70 | Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1920-21. Price As. 4. | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 71 | Season and Crop Report of the Madras Presidency for 1920-21. Price R. 1. | Issued by the Board of Revenue, Madras. | Ditto |
| 72 | Year Book of the Madras Agricultural Department, 1920-21. Price As. 10. | Issued by the Department of Agriculture, Madras. | Ditto |
| 73 | Villager's Calendar, 1922-23 .. | Ditto | Ditto |
| 74 | Annual Reports of Agricultural Stations of the Madras Presidency, 1921-22 (for official use only). | Ditto | Ditto |
| 75 | A Note on Casuarina plantation in the Vizagapatam District. Madras Department of Agriculture Bulletin No. 82. | G. Jogiraju, Farm Manager. | Ditto |
| 76 | A Soil Survey of the Godavari Delta. Madras Department of Agriculture Bulletin No. 83. | Roland V. Norris, D.SC., Government Agricultural Chemist, Madras, B. Viswanath and K. Kasinath Ayyar. | Ditto |
| 77 | Note on Monsoon Plough. Madras Department of Agriculture Leaflet No. 14. | Issued by the Department of Agriculture, Madras. | Ditto |
| 78 | Prickly Pear as fodder. Madras Department of Agriculture Leaflet No. 17. | Ditto | Ditto |
| 79 | Report on the working of the Department of Agriculture, Central Provinces and Berar, 1920-21. Price R. 1. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Nagpur. |
| 80 | Season and Crop Report of the Central Provinces and Berar for 1920-21. Price As. 8. | Issued by the Department of Land Records, Central Provinces. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 81 | Report on the Agricultural College, Nagpur, Botanical, Chemical and Mycological Research, Maharaj Bagh Menagerie and Agricultural Engineer's Section for 1920-21. Price As. 8. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Nagpur. |
| 82 | Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1920-21. Price As. 8. | Ditto | Ditto |
| 83 | Report on Agricultural Stations, Northern Circle, Central Provinces, for 1920-21. Price As. 8. | Ditto | Ditto |
| 84 | Report on Demonstration Work in the Northern Circle, Central Provinces, for 1920-21. Price As. 8. | Ditto | Ditto |
| 85 | Report on Agricultural Stations, Southern Circle, Central Provinces, for 1920-21. Price Rs. 2. | Ditto | Ditto |
| 86 | Report on Demonstration Work in the Southern Circle, Central Provinces, for 1920-21. Price As. 8. | Ditto | Ditto |
| 87 | Report on the Agricultural Stations, Western Circle, Central Provinces, for 1918-19. Price As. 8. | Ditto | Ditto |
| 88 | Report on Demonstration Work in the Western Circle, Central Provinces, for 1918-19. Price As. 8. | Ditto | Ditto |
| 89 | Report on the Agricultural Stations, Western Circle, Central Provinces, for 1920-21 Price As. 8. | Ditto | Ditto |
| 90 | Report on Demonstration Work in the Western Circle, Central Provinces, for 1920-21. As. 8. | Ditto | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 91 | Return of expenditure on the Provincial and District Gardens in the Central Provinces and Berar for the year ending 30th June, 1921. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Nagpur. |
| 92 | The Purchase of Agricultural Implements. Central Provinces Department of Agriculture Bulletin No. 11 (1921). | R. G. Allan, M.A., Principal, Agricultural College, Nagpur. | Ditto |
| 93 | Tractors on Indian Farms. Central Provinces Department of Agriculture Bulletin No. 12 (1921). | Ditto | Ditto |
| 94 | The Organization of the Department of Agriculture. Central Provinces Department of Agriculture Bulletin No. 13 (1921). | D. Clouston, M.A., D.Sc., C.I.E., Director of Agriculture, Central Provinces. | Ditto |
| 95 | Leaflet entitled Note on Manure (Dry-earth system and compost). | Issued by the Department of Agriculture, Central Provinces and Berar. | Ditto |
| 96 | Engineering Section of the Central Provinces Department of Agriculture (Leaflet; Hindi and Marathi.) | Ditto | Ditto |
| 97 | Hire-purchase system of motor tractors. Central Provinces Department of Agriculture Leaflet. (Hindi and Marathi.) | Ditto | Ditto |
| 98 | How cane growers can increase their profits. Central Provinces Department of Agriculture Leaflet. (Hindi) | Ditto | Ditto |
| 99 | By-laws for Seed and Taluq Associations. Central Provinces Department of Agriculture Leaflet. (Marathi.) | Ditto | Ditto |
| 100 | Wheat suitable for different districts of Northern Circle. Central Provinces Department of Agriculture Leaflet. (Hindi.) | Ditto | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 101 | Annual Report of the Department of Agriculture, Assam, for the year ending 31st March, 1921. Price As. 8. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 102 | Season and Crop Report of Assam for the year 1921-22. Price As. 8. | Ditto | Ditto |
| 103 | Report of the Agricultural Experiments and Demonstrations in Assam for the year ending 31st March, 1921. Price As. 12. | Ditto | Ditto |
| 104 | Tables of Agricultural Statistics of Assam for the year 1920-21. | Ditto | Ditto |
| 105 | Report of the Jorhat Agricultural Experiment Station for the year ending 31st March, 1922. | Ditto | Ditto |
| 106 | Report of the Upper Shillong Agricultural Experiment Station for the year ending 31st March, 1922 | Ditto | Ditto |
| 107 | Report of the Karimganj Agricultural Experiment Station for the year ending 31st March, 1922. | Ditto | Ditto |
| 108 | The Fodder Supply of the Surma Valley. Assam Department of Agriculture Bulletin No. 1 (1921). | Ditto | Ditto |
| 109 | Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1921. Price R. 1. | Issued by the Department of Agriculture, Burma. | Government Priuting, Burma, Rangoon. |
| 110 | Season and Crop Report of Burma for 1920-21. Price R. 1. | Issued by the Department of Settlements and Land Records, Burma. | Ditto |
| 111 | Tables of Agricultural Statistics of Upper Burma for 1920-21. | Ditto | Ditto |
| 112 | Tables of Agricultural Statistics of Lower Burma for 1920-21. | Ditto | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 113 | Annual Reports of the Agricultural Stations, the Agricultural Chemist, the Agricultural Engineer, the Economic Botanist and the Assistant Director of Agriculture (Entomology) for the year ended 30th June, 1921. | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |
| 114 | Agricultural Calendar for 1922-23 (only in Burmese). | Ditto | Ditto |
| 115 | Revision for reprinting of the syllabus for the Agricultural College, Mandalay. | Ditto | Ditto |
| 116 | Instructions for handling of cane crushers (in Burmese). | Ditto | Ditto |
| 117 | Report of the Agricultural Stations at Tarnab and Haripur in the North-West Frontier Province for the two years ending 30th June, 1920. | Issued by the Department of Agriculture, North-West Frontier Province. | Government Press, Peshawar. |
| 118 | Report on the Season and Crops of the North-West Frontier Province for 1920-21. Price R. 1-8-6. | Revenue Commissioner, North-West Frontier Province. | Ditto |
| 119 | Summary of Remarks on the Kharif Crop of the North-West Frontier Province for 1921. Price As. 9. | Ditto | Ditto |
| 120 | Report on the Operations of the Department of Agriculture and Fisheries, Travancore, for 1920-21. | Issued by the Department of Agriculture and Fisheries, Travancore. | Government Press, Trivandrum. |
| 121 | Report of the Administration of Avenues, Public Gardens and of the Agricultural Department in the Cochin State for 1906 (1920-21). | Issued by the Department of Agriculture, Cochin. | Cochin Government Press, Ernaculam. |
| 122 | Annual Report of the Agricultural Department, Gwalior State, for 1920-21. | Issued by the Department of Agriculture, Gwalior. | Alijah Darbar Press, Lashkar. |
| 123 | Annual Report of the Agricultural Department, Mysore, for the year ending 30th June, 1921. | Issued by the Department of Agriculture, Mysore. | Government Press, Bangalore. |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*concld.* | | |
| 124 | Annual Report of the Department of Agriculture, Baroda State, for the year 1919-20. Price As. 8-3. | Issued by the Department of Agriculture, Baroda. | ..... |
| 125 | *Quarterly Journal of the Indian Tea Association*, Price As. 6 per copy. | Issued by the Scientific Department of the Indian Tea Association, Calcutta. | Catholic Orphan Press, Calcutta. |
| 126 | The *Journal of the Madras Agricultural Students' Union*. Annual Subscription Rs. 2. | Madras Agricultural Students' Union, Coimbatore. | Literary Sun Press, Coimbatore. |
| 127 | *Indian Scientific Agriculturist*. Annual subscription Rs. 4. | Alliance Advertising Association, Ltd., Calcutta. | Messrs. Bera & Co., Printers, Calcutta. |
| 128 | *Poona Agricultural College Magazine*. Annual subscription Rs. 2. | College Magazine Committee, Poona. | Arya Bhusan Press, Poona. |
| 129 | The *Planters' Chronicle* (Weekly) | United Planters' Association of South India, Coimbatore. | Daily Post Press, Bangalore. |
| 130 | *Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription Rs. 3. | Mysore Agricultural Experimental Union. | Bangalore Press, Bangalore. |
| | **AGRICULTURAL CHEMISTRY.** | | |
| 131 | Investigations on Indian Opium, No. 1. Non-environmental Factors influencing the Alkaloidal Content and Yield of Latex from the Opium Poppy (*Papaver somniferum*). Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 1. Price R. 1-8 or 2*s*. | Harold E. Annett, D.Sc. (Lond.), F.I.C., M.S.E.A.C., etc., Agricultural Chemist to the Government of Bengal on special duty at Cawnpore, Haridas Sen, M.Sc., and Har Dayal Singh, B.Sc. | Messrs. Thacker, Spink & Co., Calcutta. |
| 132 | Investigations on Indian Opium, No. 2. The Effect of Environmental Factors on the Alkaloidal Content and Yield of Latex from the Opium Poppy (*Papaver somniferum*) and the bearing of the work on the functions of Alkaloids in Plant Life. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 2. Price Rs. 2 or 2*s*. 9*d*. | Harold E. Annett, D.Sc. (Lond.), F.I.C., M.S.E.A.C., etc., Agricultural Chemist to the Government of Bengal on special duty at Cawnpore. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **AGRICULTURAL CHEMISTRY** —*concld.* | | |
| 133 | Variations in some characteristics of the Fat of Buffalo and Cow Milk with changes in Season and Feeding: the Mutual applicability of the Analytical Figures for Butter, Fat and Ghee. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, Nos. 4 & 5. Price As. 12 or 1*s.* 3*d.* | F. J. Plymen, A.C.G.I., Agricultural Chemist to the Government of Central Provinces, and A. R. Padmanabha Aiyer, B.A., Assistant Agricultural Chemist, Central Provinces. | Messrs. Thacker, Spink & Co., Calcutta. |
| | **BOTANY.** | | |
| 134 | Studies in Gujarat Cottons, Part I. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 4. Price Rs. 2 or 2*s.* 6*d.* | Maganlal L. Patel, B.Ag., Cotton Supervisor, Gujarat. | Ditto |
| 135 | The Influence of Atmospheric Conditions upon the Germination of Indian Barley. Memoirs of the Department of Agriculture in India. Botanical Series, Vol. XI, No. 6. Price As. 9 or 1*s.* | W. Youngman, B.Sc., Economic Botanist to Government, United Provinces. | Ditto |
| 136 | Correlation of colour characters in Rice. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 7. Price R. 1-4 or 1*s.* 8*d.* | G. P. Hector, M.A., B.Sc., Economic Botanist to the Government of Bengal. | Ditto |
| 137 | A Handbook of Some South Indian Grasses. Price Rs. 4-8. | Rao Bahadur K. Rangachari, M.A., L.T., Government Lecturing Botanist, Agricultural College, Coimbatore. | Messrs. Butterworth & Co., Calcutta. |
| 138 | A Manual of Elementary Botany for India. Price Rs. 4. | Ditto | Government Press, Madras. |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **MYCOLOGY.** | | |
| 139 | Die-Back of Chillies (*Capsicum* spp.) in Bihar. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 5. Price R. 1 or 1*s.* 4*d.* | Jehangir Fardunji Dastur, M.Sc., Offg. Second Imperial Mycologist. | Messrs. Thacker, Spink & Co., Calcutta. |
| 140 | Coconut Bleeding Disease. Pusa Agricultural Research Institute Bulletin No. 127. Price As. 8. | S. Sundararaman, M.A., Government Mycologist, Madras. | Government Printing, India, Calcutta. |
| 141 | *Helminthosporium* Disease of Rice. Pusa Agricultural Research Institute Bulletin No. 128. Price As. 9. | Ditto | Ditto |
| 142 | Some Common Fungoid Diseases of Crops and their preventive measures. | P. C. Kar, Mycological Assistant, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 143 | The Nature and History of Ear-cockle in Wheat and its Treatment. Price As. 2. | D. Milne, B.Sc., Economic Botanist, Punjab. | Government Printing, Punjab, Lahore. |
| 144 | Coconut Stem-Bleeding Disease. Leaflet No. 15 of the Madras Department of Agriculture. | S. Sundararaman, M.A., Government Mycologist, Madras. | Government Press, Madras. |
| 145 | Note on Mildew on Grapes and How to Prevent it. Madras Department of Agriculture Leaflet No. 16. | Ditto | Ditto |
| 146 | Notes on the Smut Diseases of Juar and Their Prevention. Central Provinces Department of Agriculture Leaflet. | R. T. Pearl, B.Sc., Mycologist, Central Provinces | Government Press, Nagpur. |
| 147 | A Simple Method of Prevention of Smut in Juar. Central Provinces Department of Agriculture Leaflet. | Ditto | Ditto |
| 148 | Gwabo Disease of Paddy. Burma Department of Agriculture Bulletin No. 16. | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY.** | | |
| 149 | Life-histories of Indian Insects. Diptera : *Sphyracephala hearseiana*, Westw. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 6. Price As. 12 or 1*s.* | S. K. Sen, B.Sc., Entomological Assistant, Pusa. | Messrs. Thacker, Spink & Co., Calcutta. |
| 150 | New and Rare Indian Odonata in the Pusa Collection; Further Notes on Rhinocypha Larvæ. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, Nos. 7 & 8. Price R. 1-4 or 1*s.* 9*d.* | Major F. C. Fraser, I.M.S. | Ditto |
| 151 | Report of the Proceedings of the Fourth Entomological Meeting held at Pusa on the 7th to 12th February, 1921. Price Rs. 7-8. | Edited by T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist. | Government Printing, India, Calcutta. |
| 152 | Annotated List of Indian Crop Pests. Pusa Agricultural Research Institute Bulletin No. 100. Price R. 1-8. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist. | Ditto |
| 153 | Some Insects recently noted as Injurious in South India. Pusa Agricultural Research Institute Bulletin No. 101. Price As. 8. | T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Acting Government Entomologist, Madras. | Ditto |
| 154 | Borers in Sugarcane, Rice, etc. Pusa Agricultural Research Institute Bulletin No. 102. Price R. 1. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist. | Ditto |
| 155 | Some Indian Economic Aleyrodidæ. Pusa Agricultural Research Institute Bulletin No. 103. Price As. 8. | C. S. Misra, B.A., First Assistant to Imperial Entomologist. | Ditto |
| 156 | The Rice Leaf-hoppers. Pusa Agricultural Research Institute Bulletin No. 104. Price As. 6. | Ditto | Ditto |
| 157 | The Pink Bollworm in Egypt. Pusa Agricultural Research Institute Bulletin No. 106. Price R. 1. | Lewis H. Gough, Ph.D., F.E.S., Director of the Entomological Service, Ministry of Agriculture, Egypt. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
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| | **ENTOMOLOGY**—*contd.* | | |
| 158 | Some Pests of Cotton in North Bihar. Pusa Agricultural Research Institute Bulletin No. 108. Price As. 6. | C. S. Misra, B.A., First Assistant to Imperial Entomologist. | Government Printing, India, Calcutta. |
| 159 | *Tukra* Disease of Mulberry. Pusa Agricultural Research Institute Bulletin No. 109. Price As. 4. | Ditto | Ditto |
| 160 | Stored Grain Pests. Pusa Agricultural Research Institute Bulletin No. 111. Price As. 14. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist. | Ditto |
| 161 | Notes on Rearing Insects in Hot Climates. Pusa Agricultural Research Institute Bulletin No. 112. Price As. 7. | Ditto | Ditto |
| 162 | Hints on Collecting and Preserving Insects. Pusa Agricultural Research Institute Bulletin No. 113. Price As. 10. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist. | Ditto |
| 163 | Note on Plant Imports into India. Pusa Agricultural Research Institute Bulletin No. 115. Price As. 7. | Ditto | Ditto |
| 164 | The Weevil Fauna of South India with special reference to species of Economic importance. Pusa Agricultural Research Institute Bulletin No. 125. Price R. 1-4. | T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Assistant Entomologist, Madras. | Ditto |
| 165 | Insect Pests and General Measures for Prevention and Remedy (in Nepali.) | P. C. Sen, Entomological Assistant, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 166 | The Entomologist's Crop Pest Calendar for the Madras Presidency. Madras Department of Agriculture Bulletin No. 80. | T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Assistant Entomologist, Madras. | Government Press, Madras. |
| 167 | Bird Friends and Foes of the Farmer. Madras Department of Agriculture Bulletin No. 81. | P. Susainathan, Assistant to Government Entomologist, Madras. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY**—*concld.* | | |
| 168 | The present state of the Mulberry Silkworm Industry of the Madras Presidency and its possible improvements. Madras Department of Agriculture Leaflet No. 13. | K. T. Achaya, Sericultural Expert, Madras. | Government Press, Madras. |
| 169 | The Groundnut Bug and its Control. Bombay Department of Agriculture Bulletin No. 105. Price As. 2. | R. S. Kasargode, L.Ag., Assistant Professor of Entomology, Poona Agricultural College, and V. G. Deshpande, B.Ag., Assistant Entomologist, Konkan. | Yeravda Prison Press, Poona. |
| 170 | Some Citrus Pests in the Nagpur District. Central Provinces Department of Agriculture Bulletin No. 11. | J. L. Khare, Lecturer in Entomology, Agricultural College, Nagpur. | Government Press, Nagpur. |
| 171 | Instructions on Bee-keeping. Burma Department of Agriculture Bulletin No. 17. | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |
| | **VETERINARY.** | | |
| 172 | Annual Report of the Imperial Bacteriological Laboratory, Muktesar, for the year ending 31st March, 1921. Price As. 7. | Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Government Printing, India, Calcutta. |
| 173 | Statistics compiled by the Government of India from the Reports of Provincial Civil Veterinary Departments for the year 1919-20. | Issued by the Revenue and Agriculture Department of the Government of India. | G. M. Press, Simla. |
| 174 | The Serum Simultaneous Method of Inoculation against Rinderpest. Pusa Agricultural Research Institute Bulletin No. 120. Price As. 2. | W. A. Pool, M.R.C.V.S., Offg. Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Government Printing, India, Calcutta. |
| 175 | Notes on Contagious Abortion in Pony and Donkey Mares. Pusa Agricultural Research Institute Bulletin No. 121. Price As. 5. | R. Branford, M.R.C.V.S., Superintendent, Government Cattle Farm, Hissar, and T. M. Doyle, F.R.C.V.S., Veterinary Officer, Imperial Bacteriological Laboratory, Muktesar. | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*contd.* | | |
| 176 | Preparation of Anti-rinderpest Serum using Animals of moderate susceptibility as Virus Producers. Part I—Buffaloes. Pusa Agricultural Research Institute Bulletin No. 129. Price As. 12. | W. A. Pool, M.R.C.V.S., Offg Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, and T M. Doyle, F.R.C.V.S., Veterinary Officer, Muktesar. | Government Printing, India, Calcutta. |
| 177 | Feeding experiments at Government Cattle Farm, Hissar. Pusa Agricultural Research Institute Bulletin No. 130. Price As. 3 | R. Branford, M R C.V.S., Superintendent, Government Cattle Farm, Hissar, and E. Sewell, M.C., M.R.C V.S., Professor, Punjab Veterinary College, Lahore | Ditto |
| 178 | Annual Report of the Civil Veterinary Department, Bengal, for 1920-21. | Issued by the Civil Veterinary Department, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 179 | Annual Report of the Bengal Veterinary College for 1920-21. | Ditto | Ditto |
| 180 | Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1920-21. Price R. 1-10. | Issued by the Civil Veterinary Department, Bihar and Orissa. | Government Printing, Bihar and Orissa, Patna. |
| 181 | A Note on the origin and development of the Civil Veterinary Department, Bihar and Orissa. | Captain P. B. Riley, M.R.C.V.S, Offg. Director, Civil Veterinary Department, Bihar and Orissa. | Ditto |
| 182 | Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1921. Price R. 1-2. | Issued by the Civil Veterinary Department, United Provinces. | Government Press, United Provinces, Allahabad. |
| 183 | Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for the year 1920-21. Price As. 12. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 184 | Annual Report of the Camel Specialist for 1920-21. Price As. 2. | Ditto | Ditto |

*List of Agricultural Publications in India during 1921-22*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*contd.* | | |
| 185 | List of Horse and Cattle Fairs and Shows in the Punjab and Native States during 1921-22 | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 186 | The Treatment of Surra in Camels by Tartar Emetic. Punjab Veterinary Bulletin No 2 of 1920. Price As. 3 | H. E. Cross, M.R.C.V.S., Camel Specialist, Punjab. | Ditto |
| 187 | Spirochætosis of Fowls. Punjab Veterinary Bulletin No 2 of 1921 (English and Vernacular). | Ditto | Ditto |
| 188 | Hypoderma Larvæ in Goats. Punjab Veterinary Bulletin No. 3 of 1921 (English and Vernacular) | Ditto | Ditto |
| 189 | Recurrent Orchitis in Donkey Colts. Punjab Veterinary Bulletin No. 4 of 1921. | Ditto | Ditto |
| 190 | Transmission of Surra by Ticks. Punjab Veterinary Bulletin No 6 of 1921. | Ditto | Ditto |
| 191 | Prospectus of Punjab Veterinary College, Lahore. Price As. 3. | Issued by the Department of Agriculture, Punjab. | Ditt |
| 192 | Syllabus of Lectures for the Diploma Course at the Punjab Veterinary College, Lahore. Price As. 2. | Ditto | Ditto |
| 193 | Annual Administration Reports of the Bombay Veterinary College and Civil Veterinary Department, Bombay Presidency, for 1920-21 Price As. 7-6. | Issued by the Civil Veterinary Department, Bombay. | Government Central Press, Bombay. |
| 194 | Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1920-21. | Issued by the Civil Veterinary Department, Madras. | Government Press, Madras. |
| 195 | Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1920-21. Price R. 1 | Issued by the Civil Veterinary Department, Central Provinces. | Government Press, Nagpur. |

*List of Agricultural Publications in India during 1921-22*—concld.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*concld.* | | |
| 196 | Feeding and Management of Young Stock. Central Provinces Department of Agriculture Bulletin No. 14 of 1922. | J. V. Takle, L.Ag., N.D.D. (I)., Agricultural College Dairy, Nagpur. | Government Press, Nagpur. |
| 197 | Value of a good Bull. Central Provinces Department of Agriculture Bulletin No. 15 of 1922. | Ditto | Ditto |
| 198 | Improvement of Cattle for Draught and Dairying. Central Provinces Department of Agriculture Leaflet. | S. T. D. Wallace, B.Sc., Nagpur. | Ditto |
| 199 | Better Cattle. Central Provinces Department of Agriculture Leaflet. | Ditto | Ditto |
| 200 | Report of the Civil Veterinary Department, Assam, for 1920-21. Price As. 8. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 201 | Report of the Civil Veterinary Department (including the Insein Veterinary School), Burma, for the year ending 31st March, 1921. | Issued by the Civil Veterinary Department, Burma. | Government Printing Burma, Rangoon. |
| 202 | Notes on Glanders and Epizootic Lymphangitis. Burma Veterinary Department Note. | Ditto | Ditto |
| 203 | Cattle Breeding and Rearing. (In English and Burmese.) Burma Veterinary Department Leaflet. | Ditto | Ditto |
| 204 | Report of the Civil Veterinary Department, North-West Frontier Province, for 1920-21. Price As. 13. | Issued by the Civil Veterinary Department, North-West Frontier Province. | Government Press, Peshawar. |

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XXIV

# Review of Agricultural Operations in India 1922-23

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CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1924

This Review is a general progress report of the activities of the Agricultural Departments in India. A short summary of the progress made by the co-operative movement as directly affecting agriculture is given in Chapter VII.

The material for the review is derived mainly from the Annual Reports of Provincial Departments of Agriculture. This year's reports for the Punjab and the Imperial Bacteriological Laboratory at Muktesar were not available before going to press, and it has not, therefore, been possible to include a detailed review of their work.

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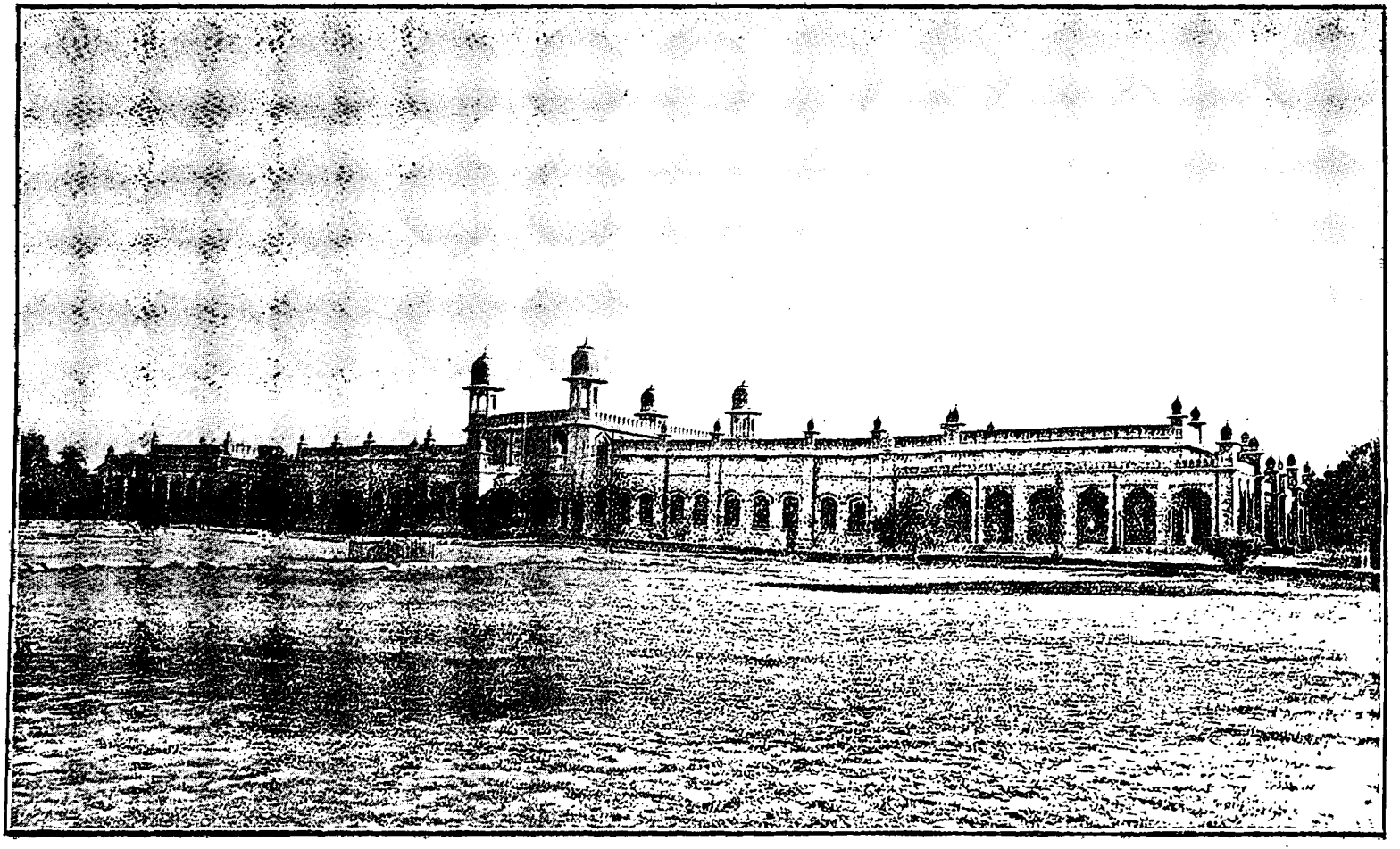

THE PUNJAB AGRICULTURAL COLLEGE, LYALLPUR.

# Review of Agricultural Operations in India 1922-23

## CHAPTER I.

### AGRICULTURAL CONDITIONS OF THE YEAR.

The monsoon of 1922 gave normal rainfall over the greater part of India, excess in the United Provinces and North-Eastern provinces, and deficient in Sind and Baluchistan. Winter depressions began early and gave very heavy rain in the Punjab plains. Taking the season as a whole, it may be classed as a favourable one from the agricultural point of view, all the important crops giving good yields with an outturn per acre much above the average.

The material condition of the agricultural population, depending as it does primarily on good seasons, was thus generally good. Although prices were easier than in the previous year, the wages of agricultural labour remained generally unchanged.

The year was also a good one for live stock. Epidemics were less severe, the ascertained mortality was lower than in the preceding year, and the climatic conditions were favourable for a normal fodder supply.

## CHAPTER II.

### ECONOMIC WORK ON CROPS.

Eighteen years ago when the officers of the reorganized Agricultural Department arrived in India, they found ready made a profitable field for work in the improvement of the crop varieties which were rarely grown pure but mixed to an extraordinary degree. The separation of the mixtures into their component parts and the testing of the economic value of the types found therein has proved a very fruitful piece of work, and the measure of success achieved in this direction is indicated in Appendix I, which, however, does not tell the whole tale. Especially in the case of wheat and cotton, the selected varieties have now come into such general use that departmental statistics fail to disclose the true extent to which they are grown.

Enormous in the aggregate although these areas under improved varieties undoubtedly are as a result of a few years' work, they are trifling compared with what can and will be done in the future, when the efforts of plant-breeding in combating disease and avoiding such natural disadvantages as short seasons, drought, etc., bear full fruit, and when special varieties of crops are fitted into the special conditions suited to their qualities.

The very success of the plant-breeding operations has, however, overshadowed other and no less important factors in crop production, such as cultural methods and the maintenance of the fertility of the soil. A knowledge of the relations between soils and plants under the varying conditions of the country is essential for a proper understanding of the agricultural situation, and the development of this side of agricultural work in India is of first rate importance. Land improvement will no doubt be a matter of slower growth than crop improvement, as capital or at least credit will have to be forthcoming for its fulfilment, but there is ample evidence in more than one province that co-operative effort will remove most, if not all, of the difficulties which are likely to be encountered.

## I. Rice.

Rice is the premier crop of India both as regards area and the value of its outturn. On an average 35 per cent. of the total cultivated area of India is under rice; in Assam nearly 80 per cent., in Burma 74 per cent., and in Bengal 70 per cent. In 1922-23, the total returned area under this crop showed a slight decline from 81,662,000* in the previous year to 81,533,000 acres, but, thanks to another favourable monsoon, the estimated yield rose from 33,160,000* to 33,167,000 tons, with an outturn per acre of 37 lb. above the decennial average.

Although India is the largest exporter of rice in the world, the Agricultural Department is working towards an increase of yield rather than an improvement in the quality from the exporter's point of view. In Burma, however, which contributes three-fourths of the exports, the requirements of the foreign market are also kept in view.

In BENGAL, paddy occupies over 21 million acres or 71 per cent. of the cropped area of the province and 26 per cent. of the total acreage under this crop in India. The efforts of the Agricultural Department in this province have thus been largely directed to the improvement of the rice crop. In Indrasail, the transplanted *aman*, and in Kataktara, the high-land broadcast *aus*, the department has varieties which are hard to beat in yield whether under optimum conditions or in unfavourable seasons. During the year under review, the Indrasail variety maintained its supremacy not only at Dacca, but also under such varying soil and climatic conditions as at Chinsura, Rajshahi, Bogra and Rangpur. Kataktara, though without a rival in Eastern and Northern Bengal (with the curious exception of Rajshahi), is not quite suitable for parts of Western Bengal where on double cropped land—broadcast *aus* followed by transplanted *aman*—it can, with advantage, be replaced by an earlier maturing broadcast *aus*. This problem has already been put in hand, and types have been secured both by hybridization and intra-varietal selection, which will probably be suitable for Western Bengal conditions. Work on deep-water paddies has also been started and

* Revised figures.

a few strains have been selected for their heavy yield, but, owing to the complexity of the problem which is, to no small degree, one of flood-resistance, the collection of considerable data over a number of years appears desirable before recommendations are made.

Further work on the transpiration of the rice plant indicates that the early races live faster, and that this quality is reflected in the ratio of the surface of leaf to root, which is markedly greater in the early races than in the later ones. Moreover, the stomata, though the same in number per unit area, are demonstratively larger.

Definite results achieved during several successive years in Bengal have established the economical value of *dhaincha* (*Sesbania*) green-manuring for *aman* paddy. The combination of phosphates with green manure, which has been so successful in dry land farming at Pusa and elsewhere, has given similar results at Chinsura.

In MADRAS, as in Bengal, rice is the main crop dealt with by the Economic Botanist. The work comprises the raising and testing of improved types, the study of inheritance of characters, and the crossing of different strains. At the Coimbatore station, 52 strains are under test, while 260 new selections were grown last year for the first time. Two new strains, CO 1 and CO 2, which give an average increase of 7 per cent., are being multiplied for distribution. Early in 1922, a new paddy breeding station was opened at Adutarai (Tanjore District) where the chief strains raised are Red Sirumani and White Sirumani, both heavy croppers. Two types of Kuruvai, one of which gives the same yield as the local crop but ripens 10 days earlier, and the other of the same duration but giving an increased yield of 16 per cent., are also under observation at this station. At Samalkota, a further trial of intermediate season varieties shows that temperature in relation to wind has a dominating effect on the growth of some of them, especially Iswarakora, which has shown an extraordinary capacity for recovering after a period of adverse conditions. A search for short duration and dry paddies suitable for North Arcot and Chittoor Districts, where this crop is raised under irrigational difficulties, is being made at Palur.

Bonemeal when applied in conjunction with green manure has been found to give a marked increase in paddy yield in soils of poor fertility, while in those of high fertility the effect is not very appreciable.

With the appointment of an Economic Botanist in BURMA the plant-breeding and selection work on paddy has now been given the recognition it deserves. The Mandalay Farm varieties T. Ngasein and T. Taungdeikpan still hold the field in Upper Burma, while in the Southern Circle the principal demand is for the Hmawbi selection known as Ngasein 8. It is estimated that over 100,000 acres are now grown with these improved types which fetch a premium of Rs. 10 to 15 per unit of 5,000 lb. The short-lived Japanese paddy called Hoito, which is mainly in demand in the dry zone district of low rainfall, is also increasing in popularity.

An experiment on the manuring of nurseries tended to support previous experience that the lead gained by the seedlings in the nurseries is lost after transplantation.

The investigation on the parboiling of rice was brought to a satisfactory conclusion during the year under review. A process has been evolved by the Agricultural Chemist, whereby hot water at 180°F. is circulated through the steeping tank until the temperature at the bottom attains 140°F. This process, having proved quite effective in suppressing the odours which make the parboiling industry a public nuisance, can be made use of with a minimum of expense by even the smallest parboiling mills, and is also said to enable the period of steeping to be reduced to about one-third of that usually required, while the colour of the parboiled rice produced is the very best attainable in practice.

The testing of the cropping power of strains of paddy derived from selected single plants continues to give results in BIHAR AND ORISSA, which appear to be reliable for the conditions under which the tests have been made. Thus, in addition to the Sabour Dahia which is a wonderful paddy for poor early land, a later variety, called Kanke No. 2, has proved considerably better at Ranchi than other paddies of its class for two successive years. A slightly later variety again, selected at Cuttack from a sample of Kakharua from Furi, has proved the best for the low lands

at Kanke and Sambalpur, as well as at Cuttack where it is known as Farm No. 2. At Cuttack an earlier variety, Farm No. 1, has beaten all others of its class.

The limit of weight which the Sabour Farm Dahia will mature is about 18 cwt. per acre and of the Kanke paddies about 25 cwt.; while the Cuttack paddies of the corresponding classes on rich land gave 50 per cent. more, although there are indications that on poor land they give less than the weaker-strawed paddies from Bihar and Chota Nagpur. It therefore appears no less necessary to adapt the variety to the quality of the soil than to its water supply.

Paddy land in South Bhagalpur treated with green manure and phosphate has hitherto not been found to contain any residual phosphoric acid or humus. The indications are, therefore, that increased crop production can be expected only if manuring is done every year.

In ASSAM, 228 types of *aus*, 332 types of *sail*, 25 types of *birain*, 60 types of *asra* and 24 types of *aman* were under observation. Of these, an *aus* (Basmati) and an *asra* (Birpak) have been found promising enough to be tried on a field scale. A new medium variety, Nagrasail, imported originally from Bengal, is also being given out for demonstration. Indrasail, Latisail, and Georgesail were tested on a field scale against Chaprasail, a local variety, and gave respectively increased yields of 416, 347 and 123 lb. per acre. All these three types are now being extensively grown in the Surma valley.

Experiments with bonemeal on paddy have given very indefinite results, but an application of 500 lb. of fish manure gave increased outturns of 276 and 271 lb. per acre during the last two years. As fish manure can be procured locally at Sylhet at very little cost, its application should prove an economic proposition.

Optimum spacing for Latisail appears to be nine inches from hill to hill, while the best yields have been obtained by planting only two seedlings per hill instead of the four or five usually employed.

The year's results in the CENTRAL PROVINCES indicate that Gurmatia 13 and Bhondu 9 are the most profitable rices for the

greater portion of the rice tract in the Chhatisgarh and Nagpur Divisions. Over a period of three years, at Raipur, the late G 13 and the medium BH 9 have given enhanced acreage profits of Rs. 9 and Rs. 13, respectively, when compared with local varieties of their class. As an early rice for unirrigated land the department offers Bhata Gurmatia which has given an annual yield of over 1,900 lb. during the last five years. The importance of early rices which give substantial outturns even in years of unsatisfactory rainfall is obvious, and the department hopes to have for distribution in the Eastern Circle a rice even earlier than Bhata Gurmatia. In the Northern Circle, where also early rices are required, Dilbuxa 17, Dilpasand and Basmatia continue to be favourites, but they may have to give way to still better varieties as the result of trials now being made on the Adhartal farm.

The manurial value of sann-hemp cut from another area and carted to the rice land is now well established, having given an average increase of about 1,000 lb. per acre over a period of seven years when applied at the rate of from 6,000 to 8,000 lb. A net profit in the neighbourhood of Rs. 40 per acre has been obtained. Sann-hemp and cattle-dung applied in conjunction with finely ground bonemeal have also proved profitable manures.

The new strains of Kolamba rice developed at Karjat in BOMBAY, while equal to the ordinary type in fineness, have materially greater yield. When grown on a large enough scale during the past year on cultivators' fields, they gave respectively 27, 25, and 16 per cent. more outturn than the *desi* mixture. These new types will be grown on at least 10,000 acres this year, and if the supply of seed on a large scale can be organized and financed, they are expected to cover the whole area of over two lakhs of acres in the North Konkan within the next five years. The results at Karjat have been so striking that Government has sanctioned the extension of similar work in the Mallad tract of the Karnatak, in the South Konkan area, and in Upper Sind.

In the laterite soil of the South Konkan and Mallad, the increases in yield obtained by applying 220 lb. of bonemeal per

acre to the rice in the field have in many cases been from 50 to 100 per cent.

The information as to the relative merits of different rices which has accumulated as the result of work on the various experimental farms is now being supplemented by a detailed survey of the rices of the UNITED PROVINCES. There can be little doubt that, as in other provinces, improved strains will be the outcome of this newly instituted line of investigation.

In the TRAVANCORE STATE, experiments designed to find out early varieties and suitable manures, to reduce the seed rate and to improve the cultural operations are in progress.

DISEASES AND PESTS. In Madras, attempts were made to persuade the ryots to adopt the method of seedling selection for controlling the ravages of the paddy stem borer (*Siga*).

With the growing practice of burning the straw on disease-affected patches, the incidence of the Ufra disease is reported to have diminished in parts of Bengal.

## II. Wheat.

Wheat stands next to rice as a single crop in India. It is the main food staple of the people of Upper India, and is grown on about 10 per cent. of the total cultivated area of the country. Owing to favourable moisture conditions at sowing time, the area rose from 28,207,000* acres in 1921-22 to 30,835,000 acres in 1922-23, but unfavourable climatic conditions at a later stage reduced the estimated yield per acre by 62 lb. with the result that the total estimated outturn of 9,891,000 tons was only 1 per cent. above the figure for the previous year.

The replacement of the country wheats by more efficient varieties of better grain quality is one of the finest achievements of the Agricultural Department. The new varieties not only combine high yield, good milling and baking qualities, strong straw and resistance to rust, but possess the added character of being able to mature with less water than the general run of Indian wheats—no small advantage in a country where water supply is the principal limiting factor in crop production. There could be no better testimony to their worth than that,

* Revised figure.

during the short space of a little more than a decade, in the two chief wheat-growing provinces (the United Provinces and the Punjab which among them carry more than half the total wheat crop) the area under improved wheats (Pusa 12, Pusa 4 and Punjab 11) is now well into the second million acres. Some of them are even making headway under such widely different conditions as the Peshawar Valley, North Sind, Kathiawar, the Nilgiri Hills and the Southern Shan States.

There is, however, an insistent demand for an improved bearded wheat in some localities where the crop is liable to damage by animals and birds. To meet this, a series of bearded varieties have been obtained at Pusa from Pusa 6 and Punjab 9 by means of hybridization. Of these, Pusa 54 has emerged successfully from the preliminary field trials, and seed is now being multiplied for trial under cultivators' conditions.

Pusa 12, Pusa 4 and Cawnpore 13 wheats have received such wide reputation in the UNITED PROVINCES that the energies of the department are concentrated on maintaining a supply of pure seed. There is still need for a high yielding, strong strawed, bearded wheat, but this is likely to be met by some of the new Pusa hybrids.

Pusa 4 is now the common wheat throughout the Peshawar District in the NORTH-WEST FRONTIER PROVINCE. That it is so was most fortunate this year, for the local Red Chauntra was almost a total failure, being afflicted with yellow rust quite early in the season, later by lodging, and finally by poor fertilization. It may therefore be stated that a failure of the wheat crop on the irrigated parts of the Peshawar District was averted by the extended growing of Pusa 4.

A thorough test of the cropping power of the Pusa and other wheats in different parts of the province has not yet been made in BIHAR AND ORISSA, but the area under improved wheats is increasing in the Patna Circle where the outturn and market rate of Pusa 12 is higher than that of the local wheat. In the flooded rice areas of Orissa, where the paddy crop is often completely destroyed, Pusa 4 is proving successful as a late sown cold weather catch crop and a scheme of seed distribution is being started. For the damp soils of the Tirhut Division in

North Bihar, where an early, rust resistant wheat of high quality is desirable, three new types—Pusa 52, 53 and 80—appear suitable. So far, Pusa 53 has given the best results at Pusa, and sufficient seed will be available this year for preliminary trials.

In the CENTRAL PROVINCES, Pusa 100 (obtained from the progeny of a cross between Mozaffarnagar and one of the Bihar wheats), Hoshangabad White Pissi, the departmental selection AO 89 and two Muria-Khapli crosses have become the standard wheats for different localities to which they are suited. With irrigation and manure in the form of oilcake, Pusa 100 and Pissi gave, in the Eastern Circle, yields of 180 and 230 lb., respectively, above the local Kathia. AO 89 is the most suitable variety to grow where no irrigation facilities exist.

A single ploughing at the beginning of the rains showed a net profit of Rs. 4-8 per acre at Hoshangabad as compared with the local practice called bakharing. In the manurial experiments on wheat without irrigation, urine earth gave the best financial returns in comparison with other nitrogenous manures. At Raipur, sann-hemp has been found to increase the following wheat crop considerably whether it is grown in *situ* and ploughed in or applied by removal from another area.

In BOMBAY, Pusa 12 and Punjab 11 have proved particularly suitable for Sind, and the demand is so great that a large import of seed wheat of the former strain was arranged for from the United Provinces. Selection work on the local types at Jacobabad has also secured some exceedingly good material for multiplication. Pusa 4 is making rapid progress in North Gujarat where it gives sometimes no less than 50 per cent. more value than the local Wajia. The needs of the wheat-growing districts of the Deccan, for which the North Indian selections are not exactly suitable, are likely to be met by a number of local pure strains which are ready for multiplication.

In the Nilgiri hills in MADRAS, a number of European planters have been experimenting with Pusa wheats and have reported good results.

Federation and Pusa 4 continued to maintain their superiority in the Southern Shan States. A commercial valuation of

the latter by the Imperial Institute shows that the quality of the grain produced in BURMA is equal to that of the best Manitoba wheat. When the railway, now under construction, is completed, the valleys of the Southern Shan States will be able to grow large quantities of high quality grain.

## III. Sugarcane.

According to the final general memorandum on the sugarcane crop for the season 1922-23 issued by the Director of Statistics, the area under sugarcane increased from some 2,400,000 acres in 1921-22 to roughly 2,750,000 acres in the year under report. This is equivalent to an increase of 14 per cent. over last year. As weather conditions were on the whole favourable in most of the provinces, the yield of *gur* or raw sugar per acre was also higher than that of last year.

India's own manufacture of refined sugar totalled 77,628 tons, which represents an increase of nearly 4,500 tons over last year, while it is estimated that the white sugar produced by indigenous methods was some 40,000 tons, making a total production of about 117,600 tons of refined sugar this year. India's requirements of refined sugar are, however, several times greater than her own production. No less than 442,400 tons valued at about 15 crores of rupees were imported during the year mainly from Java and Mauritius.

Sugar, in common with almost every other commodity, suffered from a drop in price during the greater part of the year under report, due mainly to the large surplus held in Cuba which weighed down the market and caused the adoption of a hand-to-mouth buying policy in anticipation of a further drop. On the other hand, the price of sugar has not yet approached the unprofitable stage, and the sugar industry stands out as the main industry which has continued to make money and to work full time throughout the world. The result of this has been shown clearly in the development which has taken place in the past year. The large crop of cane grown in India has resulted in a fall in *gur* prices and in the attention of white sugar factories being drawn to the utility of working on *gur* and reducing overhead charges in the off-season. This means an

increase in white sugar production in India and is all to the good, and it is hoped that it will now establish the custom of working *gur* by all mills when prices are favourable.

On the agricultural side, the work of the IMPERIAL CANE BREEDING STATION AT COIMBATORE has continued unabated and the production of seedlings is steadily being brought into line with the agricultural requirements of the different tracts. The extent and value of the work initiated and carried to a successful conclusion at Coimbatore by Dr. Barber is now receiving its due recognition, and there can be little doubt that it will for the future rank as one of the best things done by the Agricultural Department in India. It is to be hoped that financial provision will be forthcoming to enable the station to operate on a suitable scale, instead of being restricted through want of funds.

A most successful set of mill trials were initiated by the SUGAR BUREAU and carried on in the year under report on the Coimbatore canes No. 214, No. 213 and No. 210. The success of the mill trials, combined with the well known agricultural properties of these canes, has created a strong demand for seed throughout the whole white sugar tract, and as a growers' cane Co 213 is now one of the best known in India. It has also been grown in a large number of the cane-growing countries outside India, and is highly spoken of in several. Further mill trials are now in hand on a cane which, it is confidently expected, will improve on Co 214 in both tonnage and early maturity.

The work on cane at Shahjahanpur has been continued and the canes selected are now being tried out on the other farms in the UNITED PROVINCES. Here the difficulty arises that the increased crop results in ever increasing difficulties regarding crushing and boiling, and this emphasizes the importance of pushing on the work on the manufacturing side, which seems likely to hold up development of an important agricultural improvement in a crop which, by reason of its immense acreage, makes the United Provinces the most important cane-growing province in India.

In BENGAL, the work has been pushed forward on the testing of Co 213 and Co 214. Interesting results have been

obtained with manurial experiments, and by additional dressings of lime on sour soils a juice of much greater than ordinary purity has been obtained. It is also of interest to note that the Java short planting method for rapid propagation of canes is being tried, and, though local conditions differ somewhat from Bihar where it has proved a success, it will no doubt be established satisfactorily when further experience has been gained.

The Coimbatore canes grown at Sipaya in BIHAR have proved remarkably successful and the demand for seed far exceeds the supply. Work on other Coimbatore seedlings is in progress, and an interesting outturn experiment against the local Hemja has been conducted with Co 213, proving the superiority of the Coimbatore cane in every way. In the other parts of the province, work on drainage for cane holds an important place, and it is clear that, if this can be done over large areas, a vastly increased cane cultivation may be expected on lands which do not now hold it.

In the PUNJAB, Co 205 has been successful wherever grown, and the local Agricultural Department is starting a large scale distribution of this cane to the growers. Its very high yield and hardy nature, combined with the erect habit, are making it a popular seedling in parts of the Punjab. It should, however, be mentioned that it is essentially a cane for the unirrigated tracts of the Punjab.

The work done at Manjri in BOMBAY is apparently at last bearing fruit. Sugar factories have now started in the Deccan, and these, coupled with the drop in the price of *gur*, will soon expose the fallacy of over-manuring and over-irrigating, which has been such a feature in the past cultivation of Pounda in the Deccan, and enable the Manjri improvements to be pushed ahead rapidly.

Varietal tests carried out in co-operation with cane-growers in the Circars have established the superiority of J 247 over previous importations made in the MADRAS Presidency. The popular cane in Malabar is Red Mauritius, but Barbados varieties are also coming to the front.

In manurial trials at Samalkota, fish guano has proved to be a more economical manure than castor cake.

Drought considerably hampered the work on cane at Tharsa, the chief cane station in the CENTRAL PROVINCES, but as in past years Co 210 has done best, followed by J 213 and Co 204. A profit of Rs. 550 per acre, with *gur* selling at 9 lb. per rupee, was made with Co 210 which produced 8,480 lb. of *gur*. In the Northern Circle, Mauritius canes are replacing the older varieties and there would appear to be a considerable opening for these canes.

Work in ASSAM continues at Jorhat where tests have selected out B 147, B 376, Striped Mauritius, J 33a, D 74 and Co 9. It is interesting to note that the average outturn of the 20 varieties of cane ratooned came to 25 tons per acre, as, with the labour conditions prevalent in Assam, ratooning is of the utmost importance. Nine selected varieties were planted for comparison. The season was not favourable for cane, but the average yield per acre was about 30 tons. Good progress continues to be made with the popularization of three-roller iron mills and shallow boiling pans for *gur* making.

Experimental work on cane was continued in BURMA at Mandalay, Hmawbi, Hopin and Tatkon. A central farm for the study of sugarcane problems will be opened during the present year when it is hoped to centralize the work on this crop, the area of which doubled during the last 10 years.

In the NORTH-WEST FRONTIER PROVINCE, the Red Assami cane continues to show greater vigour and to require less irrigation water than the established Pounda variety. Crop cutting experiments on the farm average 26 tons per acre for Red Assami in comparison with 20 tons for the Pounda. The Coimbatore Station variety Co 213 has now been sent up to this province and has made a most vigorous start. As the whole Red Assami crop of the farm was last year laid by wind, a cane with the standing properties of Co 213 should be valuable.

HM 544 continues to grow in popularity in MYSORE and has found its way into nearly all the important cane growing areas in the State. HM 320 is another cane which seems likely to be of considerable popularity. The whole problem is being

approached in the same thorough manner as other crops have been tackled in Mysore, and the work appears likely to meet with the success it deserves.

Nothing new is to be recorded in TRAVANCORE where sets and manures continue to be distributed and demonstrations conducted. It is reported that the results of several varietal tests were uniformly in favour of Red Mauritius.

The borer is the most serious PEST of the sugarcane crop. Trapping of the moths in heaps of trash is carried on successfully in some localities at a cost of less than Rs. 2 per acre.

## IV. Cotton.

During the year under report this crop rose to 21,154,000 acres from 18,451,000* acres in the preceding year and the total estimated yield from 4,479,000* bales to 5,196,000 bales. The yield per acre was 98 lb. as compared to 97 lb. in the preceding year. The quantity of raw cotton exported during the year ending 31st March, 1923, was 3,362,601 bales as against 2,981,361 bales in 1921-22. The value of cotton goods exported was Rs. 1,306 lakhs.

It is probably many years since the Indian cotton crop was so important to the world's spinners as at present. The American cotton area of 1923 under the stimulus of high prices rose to 38 million acres which is practically a record, but the latest return of estimated yield was only some ten million bales as campared to 13—16 million bales which such an area would have indicated in the past. This is directly attributable to the damage caused by the Cotton Boll Weevil. Though more favourable climatic conditions may give better yields in America than has been the case during the present year, there is reason to fear that the present area may not be maintained, for weevil damage has made cotton growing unremunerative, except at high prices, in important portions of the cotton-growing belt.

Attention was drawn last year to the unrivalled opportunity now offered to India to place her cotton cultivation on a more stable footing by replacing very short staple cottons, which meet with a limited and none too certain demand, by cottons of $\frac{7}{8}''$

* Revised figures.

staple and upwards such as will always command attention in the world's markets. There is not the slightest doubt that the present shortage of the American crop has produced a very definite shortage of cotton between $\frac{7}{8}''$ and $1\frac{1}{8}''$ staple, nor of India's ability to contribute to the supply of such cottons. Progress, however, must be gradual. Except when new areas are brought under irrigation, there is a comparatively small margin for increase in the acreage devoted to cotton growing, owing to the necessity for providing for food grains and fodder crops. Within these limitations, and of those caused by the vagaries of the monsoon, the Indian cotton area does respond to rising prices, or, to be more exact, to an increase in the ratio between the price of cotton and other crops.

An essential factor is the checking of adulteration and the improvement of marketing in order to secure to the grower the true value of his produce and to prevent the destruction of superior cottons for commercial purposes by malpractices.

Perhaps the most outstanding event of the year in regard to cotton growing in India is the decision to proceed with the Sukkur (Lloyd) Barrage Scheme in Sind. This scheme, probably the biggest single irrigation scheme in the world, will provide perennial irrigation for some 6 million acres, of which, it is estimated, that one million acres will be suitable for irrigated cotton growing. It is already known that, given an assured supply of canal water, Sind can produce cotton of excellent staple, and that the development of this area should lead, at no distant date, to an addition of half a million bales of staple cotton to the Indian crop.

The INDIAN CENTRAL COTTON COMMITTEE completed its second year of work at the end of August; for a full account of their activities reference must be made to their recently issued report. The outstanding feature of the year has been the incorporation of the Committee as a permanent body with funds of its own under the Cotton Cess Act which provides for the levy of annas 4 per bale (2 annas per bale after March 1926) on all Indian cotton used in mills in British India or exported from India. With the funds so raised the Committee has been able to inaugurate a far-reaching scheme of research for the improvement of cotton growing. Grants-in-aid have been made

to various Provincial Departments of Agriculture to enable them to undertake problems of general importance lying somewhat outside the scope of their ordinary duties but for which they are able to give facilities, given additional funds and staff. These research schemes are referred to in connection with the provinces concerned. The Committee has also formulated a scheme for a Central Agricultural Research Institute for cotton now under the consideration of the Government of India. The scheme for the establishment of a Technological Laboratory and Experimental Spinning Plant in Bombay is well advanced. Prof. A. J. Turner, recently Professor of Textile Technology in the University of Manchester, has been appointed Director of the Research Laboratory, and at the time of writing had already sailed for India. A well-equipped Experimental Spinning Plant has been provided and will be complete and at work before the end of March. Temporary laboratory arrangements have been made pending the construction of the main laboratory. An excellent site for both Laboratory and the Spinning Plant was obtained from the Bombay Improvement Trust.

With the initiation of this scheme a long-felt want will be filled and agricultural officers engaged on the improvement of cotton will be able to secure accurate and thorough testing of any new strains which they may evolve. In addition, the characters of Indian cottons will be thoroughly studied, and judging from experience in America this cannot fail to lead to important improvements in market organization at present held up for lack of accurate information. Textile physics is a branch of research which has only recently received the attention it deserves in Europe and America, and it is satisfactory to be able to record that the second cotton-growing country in the world will no longer be backward in this respect.

In its advisory capacity the Committee has continued to do most valuable work. Its recommendations for the restriction of the transport of cotton between different areas to prevent such transport for purposes of fraudulent admixture received the approval of the Government of India and effect was given to them by the Cotton Transport Act No. III of 1923. The Act is of a permissive and enabling nature and empowers Local

Governments to schedule for protection areas growing superior varieties of cotton and to prevent the introduction into those areas from outside of cotton, *kapas* or cotton-seed except under license when required for genuine manufacturing purposes.

Early action was taken by the Government of Bombay to put the Cotton Transport Act into force in the greater part of the staple cotton growing areas of that presidency, *viz.*, the Surat-Broach tract and the Southern Division including particularly the important Kumpta-Dharwar area. The question of extending the application of the Act to Northern Gujarat has been reserved for further examination when experience of the working of the Act in South Gujarat has been gained.

The Madras Provincial Cotton Committee has recommended the application of the Act to the protection of the important Northerns and Cambodia long staple cotton areas in that presidency, and details are now being worked out. The question of the protection of Central Provinces and Berar cottons from admixture of inferior cotton from Khandesh is also under consideration.

The Central Cotton Committee's recommendations in regard to the regulation of gins and presses in the modified form referred to in last year's report have received very wide approval, and there is reason to believe that early legislation will be forthcoming to give effect to these also.

Considerable attention has been given to the question of primary cotton markets. This is chiefly a matter for Local Governments and for legislation by Provincial Legislative Councils, but the Committee has been able to advise the Government of Bombay on the details of the Bombay (District) Cotton Markets Bill which, it is hoped, will shortly be introduced in the local Legislature. It has also been able to advise in regard to the improvement of the Central Provinces and Berar markets, a question which is now receiving the attention of the Central Provinces Cotton Committee and Board of Agriculture. It is sufficient to say here that the principal change advised from the original Berar cotton markets system, so highly commended by the Indian Cotton Committee of 1917-18, lies in the inclusion in the Managing Committees of the markets of

direct representatives of cotton growers. Considerable attention has also been given to the drafting of suitable rules for the management of such markets.

*Cleaner Cotton Picking.* Certain Indian cottons at present do not command the price which their spinning value would justify on account of indifferent handling and bad picking. The examination of this question by Provincial Departments of Agriculture clearly shows that in the majority of cases cleaner picking is not a practical proposition unless sufficient inducement can be given to the cultivator to compensate for the additional labour and expense involved. The experience of Co-operative Cotton Sale Societies in the Bombay Presidency, particularly at Hubli, has shown that the trade is willing to pay for clean picked cotton in commercial lots. What is needed is a definite incentive to the cleaner picking and better handling at all stages from the grower to the mill. The Committee sought the co-operation of the East India Cotton Association, Bombay, who responded by altering their hedge contract rules to permit of a wider scale of mutual allowances for superior cottons tendered against hedge contracts. Under the new rules full allowances " on " can now be claimed for cottons two full grades above the basis. In other words, at present prices the tenderer of cotton two full classes above the basis can claim premium of some Rs. 35 to Rs. 40 per *candy* over cottons which could just pass. While it is realized that the best cotton is rarely so tendered, there is every reason to believe that this very definite step by the Association controlling the Bombay market to encourage clean cotton will have a marked effect on subsidiary markets and eventually lead to higher prices for clean *kapas* being paid to the grower.

*Cotton Boll Weevil.* The damage caused by the Mexican Boll Weevil (*Anthonomus grandis*) in America is well known. The attention of the Central Cotton Committee was drawn to the risk that this pest might be introduced to India with baled cotton from America, and that this risk is likely to increase as cotton is now shipped direct from the Southern States to India *viâ* Japan. The average import of American cotton into India during 25 years has been about 27,000 bales per annum, the imports in individual years varying from 2,000 to over 100,000

bales, the last big importation being in 1920. From information supplied by the Imperial Entomologist and by the Director of the United States of America Bureau of Entomology, it seems clear that *unless precautions are taken it will only be a matter of time before the Boll Weevil reaches India.* Once introduced there is every reason to believe that it would find conditions eminently suited to its spread. In America the Boll Weevil is credited with the destruction of something like 25 per cent. of the crop. At any rate it seems abundantly clear that the Weevil has caused a loss of at least two million bales in the American crop in each of the last two seasons, since comparatively small crops have been produced on what were almost record areas at a time when the high price of cotton gave every incentive to good cultivation and manuring. Despite very heavy expenditure, and under distinctly more favourable conditions than attainable in India, comparatively little has been achieved by way of control.

It is clear that drastic steps would be justified to obviate any risk of this pest being introduced into India, and the machinery is already in existence in the Destructive Insects and Pests Act. Millowners' Associations and Chambers of Commerce were consulted and all agreed that immediate action is desirable. The simplest solution, *viz.*, the total prohibition of the importation of American cotton in India, is undesirable, as in certain years Indian mills need this cotton—particularly when the Indian staple cotton crop is small. Fortunately an alternative exists, as it is possible to prevent the introduction of the pest by adequate fumigation with hydrocyanic acid gas. It is known that this gas destroys the weevil (which can only reach India as the mature beetle) and that this fumigant causes no undesirable effects, American experiments having proved that it affects neither the spinning value of the cotton nor the bleaching and dyeing of the yarn and cloth.

With one exception all American cotton imported into India during recent years has been landed at Bombay, and it is clearly simpler to provide fumigation at one port only. Chambers of Commerce and Millowners' Associations agree to the proposed restriction and to fumigation, the cost of which would be paid

by the importer. The Central Cotton Committee has asked the Government of India to issue the necessary notification under the Destructive Insects and Pests Act and to provide for fumigation at Bombay. This recommendation has been provisionally accepted. The Committee has now arranged for the necessary preliminary experiments to settle certain technical details. In particular it is necessary to ascertain the extent to which cotton can absorb (and subsequently evolve) hydrocyanic acid gas, the safeguards necessary, and the most practical and economical conditions for fumigation.

*Application of the Destructive Insects and Pests Act to cotton seed.* The attention of the Committee was drawn to the possibility of the present rules being ineffective either through the introduction of cotton seed from Africa into ports of Indian States or by the arrival of large consignments for which no adequate fumigation arrangements exist. They have recommended to the Government of India that either imports of cotton seed should be confined to a single port for all India (instead of attempting to arrange for fumigation at a number of ports), or the importation of cotton seed into India should be prohibited except through the Agricultural Departments. India is a large exporter of cotton seed and there is no reason for its importation except for sowing purposes. It is obvious that uncontrolled importation for the latter purpose is extremely undesirable.

It is clear that the losses which would be caused by the introduction of new insect pests are too great to justify any risks being run, especially when no commercial interests of importance would be affected by the proposed restrictions.

The Committee has continued the collection and supply of information in regard to Indian cottons. Through the courtesy of a number of exporting firms fairly complete figures have been obtained of the exports of the various kinds of Indian cotton to different countries. The provisional conclusions published in an early bulletin have been confirmed, *viz.*, that India has a small, though definite, margin of stapled cotton for export. On the other hand, her exportable surplus of short stapled cotton is almost unhealthily large and she is far too dependent on the requirements of a single consuming country.

In co-operation with the Empire Cotton Growing Corporation, efforts have been made to draw attention to the staple Indian cottons suitable for use in Europe, and particularly in Lancashire. The present demand for Indian cotton in Lancashire is keen, and if a footing can be established in the Liverpool market for the best Indian cottons, many of which at present are hardly known there, much would be done to stabilize enhanced prices for cottons of medium staple. The question of marketing in all stages lies largely at the root of the improvement of Indian cotton growing, for it is only as longer stapled varieties prove more profitable that existing short staple varieties will be replaced in general cultivation. The Committee is also indebted to the Empire Cotton Growing Corporation for the supply of important information in regard to cotton legislation in other parts of the Empire.

By invitation of the Government of India, the Committee is providing a central exhibit of Indian cottons for the British Empire Exhibition, 1924. This exhibit is being organized largely on commercial lines.

Provincial Cotton Committees have now been established in all cotton-growing provinces except in Bombay where their place has been taken, for the time being at any rate, by Divisional Committees in each cotton-growing tract. The importance of these Committees can hardly be over-emphasized. They have already shown their value as a link between the Central Committee and the provinces and will become of ever-increasing importance.

The BOMBAY PRESIDENCY with an area of over five million acres of cotton consists of five distinct cotton-growing tracts, four in the Presidency proper and Sind.

In Southern Gujarat (the Surat-Broach tract), the replacing of mixed cottons by pure strains of superior staple has been continued. The Director of Agriculture reports that in the tract south of the Tapti the short stapled *herbaceum* cotton known locally as Goghari, which at one time threatened to destroy the Surat crop entirely as a staple cotton, has now been almost entirely ousted, and the character of the district as a producer of staple cotton practically re-established. Only in limited areas is a mixture of more than two or three per cent. of Goghari

now found. This result has been obtained by intensive seed multiplication and distribution. As mentioned in last year's report, the department controls 18,000 acres of private seed farms which are supplied with pure seed and regularly inspected and rogued. In this way seed for over 2 lakhs of acres was distributed. In the tract north of the Narbada the variety 1027 A. L. F., which has been so successful south of the river, has not proved entirely suitable, and it has been necessary to try and obtain a cotton of higher ginning percentage. As a result of plant-breeding work on the Surat farm, it is now believed that a suitable strain has been obtained which combines a ginning percentage of 40 with a staple equal to Surat, and it is reported that if this year's results can be successfully repeated next year the distribution of this new hybrid cotton will be justified.

As a result of selection work in the Northern Gujarat area, selected types of Wagad cotton have been isolated with better staple and higher ginning outturn than the local mixture. These types have now been multiplied for preliminary distribution.

In the Southern Division (the Karnatak) perhaps even greater success has been achieved in the improvement by pure line selection. The pure type of Kumpta, known as Dharwar No. 1, is now rapidly replacing ordinary Kumpta cotton in Dharwar, South Bijapur and South Belgaum districts. With the assistance of Co-operative Cotton Sale Societies improved seed for 65,000 acres was distributed in 1923. Similar success has been attained with the selected type of Upland (Dharwar-American), known as Gadag No. 1, and seed for 63,000 acres has been distributed in co-operation with the Gadag Co-operative Cotton Sale Society. Both in regard to Kumpta and Dharwar-American cottons further progress has been made in obtaining still better types. Crosses of Kumpta cottons with high ginning cottons from Central India have produced strains equal in staple to the best local types with higher ginning percentage and better colour. In the case of Upland-American the testing of newly imported strains has been carried on and also attempts to further improve Dharwar-American by crossing it with staple American varieties.

The Khandesh Division differs from the rest of the Bombay Presidency in producing a very short staple cotton, but little superior to Bengals. Selections from crosses between Bani and Comilla cottons have been obtained which are well reported on by the trade as staple cottons and which also possess the high ginning percentage of the Khandesh-Roseum type. These strains are now being multiplied and tested and give great promise of yielding a cotton of $\frac{3}{4}''$ staple.

The search for better types in the ordinary Khandesh mixture proved disappointing, and the Central India types are now being examined.

It is interesting to note that the use of castor cake for manuring cotton to increase the yield is now rapidly increasing in Khandesh. This is perhaps the first instance of the widespread use of concentrated manure on a dry unirrigated crop in Western India.

On the Jamrao canal which is at present the only tract suitable in SIND for American cotton, Punjab 4 F is the standard variety, and the area under this crop has now reached about 7,000 acres. In view of the changed conditions which the Sukkur Barrage and canals will introduce, work is now in progress for the testing of cottons with better staple.

Active work is also in progress in Bombay to reduce the loss caused by insects and diseases. With the aid of a grant from the Central Cotton Committee the question of flower and boll shedding in Gujarat and control of the spotted bollworm have been actively taken up at Surat, whilst with a similar grant a thorough investigation of cotton wilt in the Karnatak has been started. Prior to the initiation of these schemes, encouraging results had already been obtained in the selection of wilt-resistant strains of *herbaceum* cotton. It is also interesting to note that Burma Wagale cotton grown at Dharwar proved almost entirely immune to wilt.

The area under cotton in the MADRAS PRESIDENCY shows a steady tendency to increase, the area during the year under report being 2,400,000 acres as compared to 1,803,000 acres in the preceding year. This is of importance as it is practically all staple cotton. Of the total Tinnevellies area of 589,000

acres, 200,000 acres are now under Karunganni (Company cotton), and it is also displacing dry land Cambodia and Uppam in the Coimbatore District.

The selected " Northerns " cotton, Nandyal 14, is estimated to have increased in area by 57 per cent., the actual seed distribution being sufficient for approximately 8,500 acres. Assistance in co-operative ginning was given, and the premium obtained over the local cotton was Rs. 50 per Madras *candy* of 500 lb., equivalent to Rs. 40 per standard bale.

The selected " Westerns " cotton, Hagari 25, was grown on double the area of the previous year. Seed for some 13,000 acres was supplied by the department, and, in addition, several thousand acres were known to have been sown by ryots with their own seed from the previous crop. The average premium obtained for this cotton over the local variety was Rs. 15 per standard bale for ryots' cotton and Rs. 20 for farm cotton.

In the Coimbatore District, private seed farms this year supplied seed for about 12,000 acres. The owners enter into an yearly contract with the department agreeing to grow Cambodia cotton with irrigation under departmental supervision. The crops are inspected and rogued to ensure the removal of plants which are not true to type. *Kapas* from the first pickings only is ginned under supervision at a central ginning factory and the lint sold by auction, the seed being reserved for distribution. The cottons from these seed farms fetched an average of Rs. 396 per *candy* (of 500 lb.) as compared to the market rate for Tirupur Cambodia of Rs. 365. The auction sales were well attended and competition keen.

Research and experimental work has been chiefly carried out at the special cotton station at Coimbatore which was completed during the year. Selection work on Cambodia cotton was continued and a large portion of the seed farm area is now under a selected type. Work was also continued on Bourbon, Webber 40 and Durango cottons. The $F_2$ generation of the *roseum-indicum* cross was raised during the year. Selection work on " Westerns " and " Northerns " cottons is also being carried on at the Hagari and Nandyal stations respectively. At stations

other than Coimbatore, work is under the general supervision of the Cotton Specialist and is carried out by assistants trained by him. With the aid of a grant from the Indian Central Cotton Committee, the study of the *herbaceum* constituent of "Westerns" cotton has now been taken up.

The question of bud and boll shedding has continued to receive attention, and the preliminary results obtained suggest that it may be possible to obtain an increase in crop greater than is ever likely to be produced by plant-breeding alone.

Work on the bollworm and the cotton stem weevil has been continued by the Cotton Specialist and the Government Entomologist in collaboration. During the year an extension of time for the removal of cotton plants under the Pest Act was granted with unsatisfactory results, and it is clear that a return to the original date, August 1st, is highly desirable.

The area under PUNJAB-American cotton during the year under report was 390,000 acres, the area sown in 1923 being 593,000 acres which is a distinct increase. Both the 1922 and 1923 crops were satisfactory in quality, a striking feature being the almost entire replacement of *desi* by American cotton in the Lower Bari Doab Canal Colony and the large area under the newer selection 285 F which is considerably superior to 4 F in staple. Another selection, 289 F, of still longer staple was grown for the first time on a small commercial scale in 1923. Punjab-American cotton is at present keenly in demand for export to Europe at very remunerative prices. The least satisfactory feature of the situation is the large amount of mixing which is going on in ginning factories, with the result that much of the cotton sold is very markedly inferior to the cotton grown. Unless this can be stopped, the reputation of this cotton is very seriously threatened.

With the aid of a grant from the Indian Central Cotton Committee an important scheme of cotton research has been initiated, the Committee providing a special Cotton Botanist. Though there has fortunately been no repetition of the unsatisfactory yields of 1919 and 1921, there is still much to be done before American cotton growing in the Punjab can be said to be in an entirely satisfactory condition.

In the UNITED PROVINCES, the Director reports that the hardy, high ginning, short-stapled cottons are still most remunerative despite the considerable modification of the class of cotton required by mills and especially by local mills. Through lack of irrigation facilities the growing of Cawnpore-American cotton has been largely discontinued—an unfortunate occurrence at a time when a profitable market for such cottons is assured. In the Central Circle the cultivation of the selected *desi* cotton J N 1 continues to expand. This cotton is markedly superior in staple to Bengals and meets with a ready demand from the local mills. In the Muttra District the cultivation of a strain of K 22 has extended round the Raya farm and local agents now pay a premium for this cotton, but difficulty is still experienced with its germination. From the Aligarh white-flowered cotton a race with a better lint but with the high ginning percentage and hardy habit of the original stock has been isolated and will be distributed as seed accumulates.

In the CENTRAL PROVINCES, with the aid of a grant from the Indian Central Cotton Committee, arrangements have now been made enabling the senior Economic Botanist to devote the whole of his time to cotton research, the Akola farm having been constituted as a special cotton research station. Work with the object of improving the staple of the cottons of the Central Provinces and Berar has now been seriously taken in hand. An interesting feature of the year has been the increase in the cultivation of cold weather cotton in the south of the province in the Chanda and adjoining districts. The conditions in this area approximate somewhat in those of the "Northerns" and "Westerns" cotton areas; the cotton grown is distinctly superior in staple, and though the yields are low, cultivation is inexpensive and the profit realized compares favourably with that obtained from other crops.

Cambodia cotton continues to show promise in both Middle and Upper BURMA and considerable quantities of seed have been issued for the coming year. Progress in the establishment of this crop must necessarily be gradual, involving as it does a new system of cultivation. The survey of the Wagale (early) cottons has

given extremely useful results, one strain in particular showing an average staple of $\frac{3}{4}''$. Work on the cotton survey is continuing and is of considerable importance, as comparatively little is known of the Burma cottons, especially of those of the Shan States some of which are of excellent staple. With the recent strengthening of the staff of the department and fuller equipment of experimental farms more rapid progress may be expected. Selection work is also in progress on the longer stapled Wagyi (late) cotton which is in many ways not unlike Broach which is the principal cotton of the Thayetmyo tract.

The Agricultural Department of the HYDERABAD STATE continued to spread the cultivation of the long staple Gaorani (Bani) cotton. The area sown with the seed supplied by the department during the year under report was 398,243 acres as compared to 513,115 acres in the previous year. Seed from the best areas was purchased and distributed in the areas where the cotton is mixed. The cultivation of Gaorani has been considerably encouraged by the higher prices paid by Bombay mills for this cotton, and the demand for seed is increasing.

The study of the Sannahati and other indigenous cottons and selection work on Cambodia and Dharwar-American cottons has been continued in MYSORE. Seed of selection 69 was distributed on a fairly large scale to ryots in suitable areas with satisfactory results.

As in previous years, cotton work in BARODA was carried out in close co-operation with the Bombay Department of Agriculture, the Baroda cotton tracts being interlaced with the adjoining Surat District. A special officer has been appointed to supervise cotton improvement work in the Navsari District, and from six seed depôts over 300,000 lb. of seed has been distributed. The object aimed at is to establish one uniform type throughout the whole area south of the Narbada corresponding to the policy of the Bombay Department of Agriculture in their adjoining areas. The Baroda State have recently intimated their intention of passing an Act on the lines of the Indian Cotton Transport Act and to notify areas corresponding as nearly as possible with the cotton areas of the Bombay Presidency.

A cotton survey is at present in progress in BENGAL. There are roughly 60,000 acres of cotton in Bengal, of which only about 5,000 acres are cottons of the ordinary type grown in the plains. The remainder is a coarse short-stapled type known as Comillas, which is chiefly used for mixing with wool. The result of cotton investigation at present indicates, so far as Eastern Bengal is concerned, that as good a yield may be expected as in other parts of India, but that the whole question is one of economics, cotton being in direct competition with such crops as jute and sugarcane. In Western Bengal, however, it is considered that there is much land now under a precarious transplanted paddy crop which ought to be under high-land crops, such as cotton, in rotation with maize or millet with *rahur* (*Cajanus indicus*). It is considered that here an early maturing type of cotton will be successful.

INSECT PESTS. In Madras the investigation of the bionomics of *Platyedra gossypiella* and *Pempheres affinis* was continued, especially with reference to checking the effect of the enforcement of the Pest Act as regards actual control of insect pests of Cambodia cotton.

In the United Provinces work has been done on bollworms (*Platyedra* and *Earias*) but no details have been communicated.

In the Punjab particular attention was devoted to the parasites of *Earias insulana* and thirteen different species of these were found and their life-histories worked out. The attack of Pink Bollworm (*Platyedra gossypiella*) was considerable in some localities, *e.g.*, Sialkot and Ferozpur, a sample of lint and seed from Sialkot, weighing 150 oz., containing 370 living caterpillars. Cotton Stem Borer (*Sphenoptera gossypii*) was also quite serious, in some cases over fifty per cent. of the stems being attacked; removal and subsequent burning of the attacked stems proved an effective remedy.

In Burma investigation of cotton pests showed that early sowing evaded the pests to such an extent that very little damage was done.

The above are the main lines of work done on cotton pests but in addition a considerable amount of routine work has been done in this connection.

## V. Jute.

Amongst the lower grade fibres, jute is far and away the most important, and North-East India at present enjoys a monopoly of the world's production. It is the essential requisite of international commerce, and the demand for it is governed mainly by the trade conditions of the world in other commodities. It is, therefore, natural that the trade depression brought about by post-war conditions should have affected the acreage under this crop which, although showing a slight increase over the figure of the previous year, amounted to only 1,800,000.

The estimated yield per acre (1,143 lb.) showed an improvement by 93 lb., and the total outturn is estimated to be 5,408,000 bales of 400 lb. each, which is better by 1,423,000 bales than in 1921-22. The value of raw and manufactured jute exported during the year was Rs. 63,02 lakhs as against Rs. 44,04 lakhs last year. This was, however, due more to the higher prices prevailing than to any material increase in the quantity of exports.

Two main species of jute are cultivated in India, *viz.*, *Corchorus capsularis* and *C. olitorius*, but it is from the former that the great bulk of the crop is derived. There are numerous varieties of both species, and it is to the credit of the BENGAL Agricultural Department that they have isolated and brought into general cultivation superior yielding, disease-resistant strains of both species.

The *capsularis* races R 85 and D 154, selected from the well-known Kakya Bombai for their resistance to chlorosis, continue to give pronouncedly higher yields, and there is a strong demand for departmental seed. These are not only better yielders in a good year, but their advantage is even more marked in a bad year. It has been found, for instance, that they can be sown on high land with a reasonable certainty of yielding a profitable crop three weeks or a month later than would be possible with races non-resistant to chlorosis. Only 40 tons of seed could be supplied for last season's sowings, whereas it is estimated that ten times the amount could have been easily

disposed of. The total area under departmental seed is now a matter of conjecture, but it can safely be asserted that it is not much below one-sixth the total acreage under jute in Bengal. The effect of this on the total crop can be gathered from the interest taken by the jute trade. Some of the firms dealing in the finer qualities of the fibre are perturbed as to the possibility of the finer races, which are poor yielders, being eliminated by the coarser, high-yielding selected races.

The *olitorius* Chinsura Green is still without a rival, some of the recorded yields being phenomenal. Its distribution is at present confined to Eastern Bengal which is not an *olitorius* district, but, once it is made known to the cultivators in the Dēsi and Tosha districts, there should be a big demand for the seed.

Selection and cross-breeding work on jute was continued during the year, and there are at Dacca in the present season 600 single plant cultures. These include a number of hybrids, some of which are promising, and a few have been multiplied sufficiently to come into varietal tests. Other cultures are the results of crossing " chlorotic " with " non-chlorotic strains," and appear to indicate that the tendency to chlorosis is more extensively inherited through the female than the male parent. Cultures are also grown to discover whether the length of ultimate filament is constant between plant and plant within the race, and to evolve races of long ultimate filaments for crossing purposes.

Manurial trials have given an interesting clue as to the connection between the supply of plant-food and the incidence of fungus disease in jute; this work is being carried out in collaboration with Pusa.

Complaints having been received from jute firms that the use of water hyacinth in the retting of jute results in a weak fibre, a large number of experiments were conducted on the subject during the year. It appears by using this plant not only can the retting process be expedited by several days, but if the fibre is extracted at the critical period excellent quality is obtained. The cultivator is not probably aware of this use

for the weed, and steps are being taken to spread information on the point.

In ASSAM, the Kakya Bombai variety has definitely established its superiority over the local varieties as well as the other Dacca selections D 154 and Chinsura Green. The demand for departmental seed was so high that the price went up to Rs. 75 per maund of 82 lb. The experiment of growing jute and *sail* paddy in the same year was tried at Karimganj with success. The single paddy crop gave an yield of 2,696 lb. per acre against an outturn of 1,802 lb. of jute and 2,357 lb. of paddy in the double-cropped plots.

In the Ganjar tract of the UNITED PROVINCES, where conditions similar to those existing over large areas of Bengal prevail, the area under jute has expanded to 300 acres during the last three years. With better arrangements for marketing the produce, the area can be considerably extended, as jute has proved a much more remunerative crop than those usually grown in this district.

## VI. Other fibres.

*Sann-hemp.* Work in connection with the artificial extraction of the fibre has been continued and considerable progress made during the year in estimating the possibilities of the machine in use at Pusa. Certain modifications are still necessary, but on the whole the results were promising. It is hoped to conduct mill tests during the present year with the fibre extracted during last season.

The question is one of very great importance in both the United Provinces and the Punjab where the introduction of sann-hemp as a green manure depends on whether the cultivator will be able to utilize the fibre and recoup his expenditure. The absence of retting facilities makes an artificial process the only method possible, and it is to arrive at a process suitable for small holders and not too complicated that these experiments were commenced.

Breeding work on this crop is contemplated in the United Provinces.

*Sida.* There is possibility of this fibre coming into prominence to supply finer quality yarns in place of jute. A small parcel sold for American mills fetched as much as Rs. 40 per maund (82 lb.).

*Rhea.* The high price of cotton has again created interest in this fibre. The areas in Rangpur and Dinajpur are shrinking, and unless the producer and manufacturer can agree as to who is to be the pioneer there is little chance of any advance in trade.

## VII. Tobacco.

On an average a little over a million acres are occupied by tobacco in India, of which about half the area is situated in Bengal and Madras. The other tobacco tracts of importance are in Bihar, Burma and Bombay. They produce a coarse article which to some extent meets the local taste, but during recent years the cheap foreign cigarette has replaced the *hookah* and the *biri* to a considerable extent, and what is most required now is the introduction of finer grades of tobacco for the indigenous cigarette industry. Similarly, the production of genuine Indian cigars can be assisted by providing a better outer leaf or wrapper of finer tobacco.

The work on this crop at PUSA has resulted in a type (No. 28) which combines yield and quality and is suitable for cigarette making and general cultivation. The demand for its seed continues to be insistent, and during the year under report about half a ton sufficient to sow about 70,000 acres was supplied.

Trials of Sumatra, Turkish, American and Mauritius varieties, and experiments on the improvement of local varieties by selection and on the manurial requirements of the crop are in progress on the BENGAL tobacco farm at Burirhat (Rangpur). The reputation of the Sumatra leaf grown on the farm as a cigar wrapper has now been well established, and the demand for seed amounts to several times the supply. A better filler than Sumatra is, however, wanted, and seven varieties are being tried to find the required substitute. Among the indigenous varieties, Bhengi has proved to be the heaviest yielder and fetches the highest price from the Burmese dealers who make

the well-known Burma cheroots out of this variety. Of the cigarette tobaccos under investigation, Turkish blended with Ohio is probably equal in standard to " Scissors " or " Polo " sold in the market. Orinoco and White Burley, which seem to be decidedly stronger, will probably prove more suitable as pipe tobaccos. The manurial experiments indicate groundnut cake and fish manure as most suitable for tobacco, while an open and well pulverized soil has once again proved to be a critical factor in the production of a high quality leaf. Difficulties have been met with in experiments in flue curing owing to the dryness of the atmosphere, but these are in process of being surmounted.

One of the Rangpur varieties—Motihari—has proved very successful wherever grown in ASSAM. A collection of the indigenous varieties has also been made at Karimganj to study their characteristics.

Pusa 28 is finding favour in BURMA where it is reported to yield more and finer leaves than any of the local varieties. To facilitate systematic work on this crop it is proposed to establish a special tobacco farm and a curing station and also to obtain the services of an experienced curer from Bengal.

The initial work on the Nadiad farm in BOMBAY has resulted in the isolation of a number of promising types.

## VIII. Oil-seeds.

The area under the principal varieties of oil-seeds—linseed, rape, mustard, sesamum and groundnut—declined to 17,115,000 acres from 17,225,000* acres in 1921-22, but the yield rose from 3,080,000* tons to 3,392,000 tons. The total quantity of oil-seeds (including cotton and castor seeds) exported during the year was 1,096,800 tons (valued at Rs. 27,35 lakhs) as against 735,000 tons (valued a Rs. 17,40 lakhs) in the previous year. Even with this sudden rise of nearly 50 per cent. in the export, the total is still far below the pre-war average : local crushing has certainly increased considerably.

*Linseed.* A detailed study of the unit species of the Indian linseed crop at Pusa has yielded important results both from

* Revised figures.

the scientific and economic points of view. A number of the unit species, isolated from the mixtures grown on the alluvium, are found to yield about 40 per cent. more than the ordinary crop. Nearly four cwt. of seed of these promising types has been issued for preliminary field trials. The unit species suitable for the black soils of Peninsular India are being tested in the Central Provinces.

*Castor.* Further work on castor at Sabour in Bihar failed to discover any appreciable influence on the oil-content of the seeds through climatic or soil conditions, provided they are properly matured. The oil-content of different varieties under cultivation is also being investigated in the United Provinces.

*Sesamum.* The search for a higher yielding variety than the previously selected Pyigyi has been entrusted to the newly appointed Economic Botanist in Burma. In the United Provinces high oil-content is being arrived at.

*Groundnuts.* Owing to the great economic value of groundnuts and the fact that they grow well on light land, selection work and varietal tests on the crop are in progress in most of the provinces. Groundnuts are now grown on over 25¼ lakhs of acres which is more than five times the average area occupied in the quinquennium ending 1904-05.

Experiments at Mahalaing and Tatkon in BURMA have established the decided superiority of the erect Spanish type over the Burmese varieties. The former is not only popular with the millers on account of its 16 per cent. higher oil-content, but the cost of harvesting is reduced by about one-half. Being much earlier, this type also admits of being grown as a second crop after early sesamum or as a double crop with pigeon-pea or Cambodia cotton. As its erect habit allows interculture to be done, it is suitable for introduction in weed-infested areas.

An erect type of plant with a short duration of 4 to 4½ months is being tested at Anamalai in MADRAS. Varietal and single plant selection work is also in progress at Naduvirapattu.

In the CENTRAL PROVINCES, trials are being made to arrive at a type having an early habit and erect growth but at the same time yielding a large seed. It is recognized that this

would be an improvement on the small Japanese groundnut which the department now recommends as an early ripening *kharif* crop to be followed by a *rabi* where irrigation facilities exist.

On the sandier soils of Chota Nagpur in BIHAR, upright Type 17, if sown early and manured with gypsum (costing Rs. 3 per acre), leaves a profit greater than the value of the usual gross return from such lands.

Owing to the excessive cost of harvesting in a soil which sets hard after the rains are over, groundnut is not making the progress in the highlands of Western BENGAL at one time hoped for. On the other hand, the crop is reported to be a success not only on sandy *diara* lands but also on the almost sterile light soils in Nadia.

*Coconuts.* In Madras, the coconut palm is under investigation on four stations. The improved methods originally adopted at Kasargod which consist mainly in surface planting in deep pits and in the maintenance of a soil mulch over the whole area, are showing striking results at the new plantations at Nileshwar and Pilicode. The system of putting out three months old seedlings in October, to avoid the set-back usually caused by the monsoon, was a complete success in the sandy soil of Nileshwar, but at Pilicode termite attacks proved too strong. A nursery of 692 seedlings has been planted at Nanmunda to ascertain whether there is any relation between rapidity of germination and future vigour of growth, while systematic experiments have been started at Kasargod to test the value of different manures. The investigations into the relation of date of harvesting to yield of oil and *copra* indicate that the April-May harvest yields the largest size and also number of nuts, while the December-January nuts are the smallest. The latter have, however, been found to have the highest oil-content.

In ORISSA, varietal trials are in progress at Cuttack, while at Balasore manurial experiments are being carried out with palms planted on very poor sandy soil. A site has also been selected at Puri, within a mile of the sea, for a coconut farm where a few selected trees of the local variety will be laid out.

A new coconut station is being started at Akyab in BURMA. The dwarf coconuts are reported to be doing well at Hmawbi.

In TRAVANCORE, spacing and manurial experiments are in progress. A number of seedlings of disease-resistant varieties were given out during the year.

The campaign against *Nephantis serinopa*, a serious PEST of coconuts, was carried on vigorously in Madras where the Pest Act was applied to compel owners to cut off and burn the attacked leaves. The practice of curing the stem-bleeding disease by operation is now being largely resorted to.

## IX. Tea.

The area under tea, about 83 per cent. of which lies in Assam and in the two contiguous districts (Darjeeling and Jalpaiguri) of Northern Bengal, was practically maintained, the figures being 708,000 acres as against 709,000* in the preceding year. The estimated yield was, however, higher, being 310,653,000 lb. as against 274,264,000* lb. in 1921, the average production for the whole of India working out at 439 lb. per acre as against 387 lb. in the previous year.

The market was brisk for all sorts of tea, the prices ruling during the year being the highest ever known since the beginning of the industry in North-East India. It is stated that the outturn would have been much greater but for the shortage of labour. Owing to this serious handicap, not only is it impossible to start new plantations, but large areas under tea are going out of cultivation.

Experiments conducted by the scientific staff of the Indian Tea Association are in progress to determine the factors influencing the quality of tea under varying conditions of fermentation, and with improved markets attention is also again directed to improvement of yields, particularly through soil treatment. A study of the various micro-organisms present during the manufacturing process has definitely established that the flavour and aroma of tea can be influenced by the use of pure cultures of these.

* Revised figures.

In Southern India, the crop continues to be dealt with by the agricultural staff of the planting districts who are paying particular attention to improved methods of manuring.

## X. Coffee.

The Indian coffee industry is practically confined to Southern India, comprising the Madras Presidency, Coorg, and the States of Mysore, Travancore and Cochin. The total area reported under the crop was 131,655 acres—an increase of 4,382 acres over that of the preceding year. The production of cured coffee during the year amounted to 25,467,687 lb. as compared with 20,586,644* lb. in 1921. The good prices ruling for all grades of coffee, together with the comparatively low exchange value of the rupee, assisted materially in improving the financial position of the industry.

Jackson's coffee hybrid and Kent's Arabica, a selected strain, continued to be popular, and considerable quantities of both were exported to various countries. An examination of these two varieties, grown under the conditions found on the experiment station, revealed the fact that the selection is less affected by disease and retains its leaf better than the hybrid. Whether this quality of disease resistance is due to physiological vigour or is a physical attribute of the leaf itself has not yet been established, but information available up-to-date points to the latter conclusion.

The value of spraying against leaf disease and anthracnose or die-back was demonstrated during the year, but experiments are being continued to find out whether the effects are cumulative; and if so, to what extent. One noticeable feature was the size and vigour of the pike and blossom on the sprayed bushes.

## XI. Rubber.

Rubber is grown mainly in Southern India and Burma. In the year under review the area amounted to 127,458 acres, an increase of about 3 per cent. above that of 1921. Only 61,086 acres were, however, tapped. The total production of raw rubber is reported to be 11,820,286 lb. as against 9,056,430 lb.

* Revised figure.

in the previous year, due doubtless to the welcome improvement in the market.

The problem of budding Hevea rubber under local climatic conditions is being investigated in Southern India where it has been discovered that suitable bud material can be obtained by pollarding the mother tree. But the difficulty of obtaining suitable material is proving insuperable, for not more than 20 trees of the 2,000 examined during the year possessed a laticiferous system of such a developed character as will justify their employment as bud material.

The work of the Rubber Mycologist on the anatomy of Hevea rubber is expected ultimately to throw some light on the puzzling phenomenon that this tree in South India appears to remain stationary in yield or actually to decline after the twelfth year of its age.

The elaborate series of manurial experiments laid down to control the secondary leaf fall caused by *Phytophthora Meadii* have proved disappointing, but certain individual trees have been found each year to remain unaffected and steps are being taken to ascertain whether this is a constant character possessed by individual trees.

## XII. Fruit.

Fruit growing, on account of its being mainly a subsidiary industry, has not received as much attention as crops, but in parts of North-West India where systematic efforts have been made to establish better varieties of fruits and to improve the methods of cultivation, packing, etc., the results on the whole have been satisfactory. It should, however, not be forgotten that, whereas in agriculture the results of improvements can be made rapidly available by the distribution of seed, this is not the case to the same extent with fruit trees. Improved varieties cannot be multiplied so rapidly, and although a certain number of improved plants can be distributed, any general increase must depend on the dissemination of a knowledge of the correct methods of grafting, propagating, etc. The development and improvement, therefore, of fruit culture depend upon the multiplication of central gardens stocked with good varieties and man-

ned by trained superintendents. Much progress cannot accordingly be anticipated until a special horticultural section is attached to all Provincial Departments of Agriculture.

In the NORTH-WEST FRONTIER PROVINCE, much good work has been done on fruit culture. The foreign varieties of peach and plum introduced at the Tarnab farm are now being grown extensively. They not only yield more, but are less subject to disease and serve to prolong the season by about two months. A French variety of apricot, the Kieffer and Le Conte pears, and the persimmon are other fruits which are being widely asked for. The Washington navel orange, though surpassing all other varieties in vigour of growth, has been found to bear light crops of large, rather coarse fruits of poor flavour, and the search for a really good and suitable orange which can compare favourably with the Lahore or Nagpur Sangtara continues. A valuable seedling orange was discovered at Bannu this year. With skin of the finest texture, even if the rind is somewhat thick, with delicious flavour and pleasing aroma, this seedling may have a great future in the orange groves despite its numerous pips.

BOMBAY is the first of the provinces to engage a whole-time horticulturist on its agricultural staff. One of the many interesting results obtained during the year is the increase in yield of fig trees as a result of notching the branches.

The pomological station opened in 1920 at Coonoor in MADRAS has now been fully planted up with all kinds of fruit trees, and a large number of grafted plants raised during the year found a ready sale. A large demand for small fruits for jam making has followed the establishment of a Fruit Preserving Institute. Varietal tests with plantains at Samalkota indicate that the variety Chekarakali requires more irrigation than others but is capable of withstanding water-logging. It has also been found that fruit from trees manured with farmyard manure possess the best keeping qualities.

At the Chhindwara farm in the CENTRAL PROVINCES, imported fruit trees have made a good start, and it is hoped that the trials now under progress will open up a new type of improved and specialized agriculture in the plateau districts.

An orchard for the study and propagation of tropical fruits is being opened at Hmawbi in BURMA. A horticulturist has been recruited and work will begin this year on mangoes, mangosteens, durians and other fruit trees. Cacao, African oil palm, Nagpur oranges and various other citrus varieties are also being established.

The fruit-growing experiments at Shillong are being continued by Mr. Holder, to whom the orchard has been leased by the ASSAM GOVERNMENT for ten years. He has established the suitability of the Khasi wild pear and plum stocks as a basis for grafting and the value of bonemeal as a manure for pear trees.

Spraying operations were successfully carried out in all fruit-growing tracts against various DISEASES AND INSECT PESTS infesting the orchards.

## XIII. Fodder Crops and Grasses.

In the greater part of India, crops grown purely for fodder are the exception, the cultivator depending mainly on the straw of his grain crops for his cattle, supplemented by a certain amount of stubble grazing. Fodder crops have, therefore, not been hitherto subjected to the same systematic treatment as the staple crops. No doubt the introduction of higher yielding varieties of food crops has resulted in a proportionate increase in the available dry fodder, but, on the other hand, the extension of arable cultivatin, coupled with stricter conserving of jungles as reserves, has tended to reduce the green food previously supplied by grazing areas. How to replace the latter, which is an essential addition to the diet of animals which subsist mainly on dry stalks and leaves, is the main fodder problem now facing the Agricultural Department. The smallness of individual boldings and the absence of irrigation facilities do not permit of an increase of areas under fodder crops, but the introduction of cold weather leguminous catch crops to leaven the straw diet would do an immense amount of good.

At PUSA, the cultivation of lucerne on flat beds, two feet wide with irrigation furrows one foot wide between the beds, instead of on ridges, has been found to increase the yield, to preserve

the texture of the soil, to save a large amount of water and also reduce the cost of weeding. Last year a plot manured with 1,600 lb. of powdered rape cake gave eight cuts at the rate of 70,000 lb. fodder to the acre. It is expected that both the number of cuttings and the total yield will be considerably increased by the application of light dressings of leaf compost made on the Chinese system. A method of preparing lucerne hay without loss of leaf has also been evolved at Pusa. It mainly consists in turning the crop when there is a certain amount of dew on it and completing the curing process in long heaps made with the butts outward and the tips towards the centre.

As stated in last year's review, berseem, the famous Egyptian clover and soil renovator, is grown at Pusa as a winter grazing on flooded land and is followed in the same year by a crop of early maize without the addition of manure (Plate I). During the year under review, 40 acres of this land were cropped. The outturn of the berseem, as estimated from the harvested plots, amounted to 40,000 lb. per acre, while the following maize crop yielded an additional 24,000 lb. of green fodder per acre. The latter was stored in pit silos which have been found more satisfactory than the tower silos previously in use.

The introduction of both these valuable fodders in the general rural economy is handicapped by the absence of an indigenous seed supply. In the North-West Frontier Province, where berseem bids fair to oust shaftal from popular favour, a fair amount of seed is obtained, but in the plains the yield is negligible. A beginning has, therefore, been made at Pusa in the study of the conditions necessary for seed formation in lucerne and other leguminous fodder crops.

The BOMBAY department is investigating the renovation of poor pastures. The experience of the last ten years points to the conclusion that grass lands can be improved greatly in the first instance by rest until they recover from the exhausting treatment to which they are normally subject, and thereafter by rotational grazing or cutting. This recommendation has been put to a practical test in a village in the Nasik District where about 800 acres of grass land are administered by the village co-operatively on the old panchayet system. Annually 200 acres are set

MAIZE AFTER BERSEEM ON NEW RECLAIMED FLOODED LAND AT PUSA.

PLATE II.



ON KIKUYU AT TARNAB, PESHAWAR DISTRICT.

apart for grazing and 600 for cutting, giving enough and to spare for all the village cattle.

The storage of *juar kadbi* (dried sorghum stalks), on a large scale and in portable form, in years of plenty, is another useful activity in this province. The Kopergaon depôt, which supplied no less than 3½ lakhs of lb. of first class dry fodder during the 1920-21 famine, has been replenished during the year, and it is hoped to store 25 lakhs of lb. of fodder at another centre in the Dharwar District in 1923-24.

It has been ascertained in the UNITED PROVINCES that the most efficient use of grazing grounds is to paddock them off in the early rains, silage the grass produced and then graze them, using the silage when the grass is deficient.

A survey of the indigenous grasses has been made in BURMA and the results embodied in a Bulletin. Both at Mandalay and Tatkon, the saccoline introduced from New South Wales promises to prove of great value. Some seed of this exotic millet was given out to the cultivators last year.

Several new varieties of grasses have been obtained from Bombay for trial on the Jorhat farm in ASSAM. Guinea-grass gave a total outturn of 18·4 tons per acre in eight cuttings between April and October.

The newly started animal husbandry section in the CENTRAL PROVINCES has begun trials with a number of fodder crops.

In BIHAR, both at Sabour and Pusa, *math* (*Phaseolus aconitifolius*, has proved the highest yielding fodder pulse.

A new grass (*Pennisetum clandestinum*), brought from South Africa where it is called Kikuyu, is being grown at Tarnab in the NORTH-WEST FRONTIER PROVINCE (Plate II). It is a nutritious, perennial, running grass of extraordinary vigour, with thick rhizomes and abundance of foliage. It has the reputation of remarkable drought-resistance. As it is not known to have produced seed, there is little danger of the grass spreading to cultivated fields whereon it might be undesirable.

The propagation of the sub-tree mesquite (*Prosopis juliflora*), the beans of which are likely to prove an useful famine food, has also been taken up at Tarnab. The mesquite grows vigorously

in an arid climate and yields more fuel in a shorter space of time than any other tree known under such conditions. Its value does not consist in the pod alone, the flower spikes yielding honey in abundance.

## XIV. Juar (Sorghum).

An area of over 28 million acres is covered by this important food and fodder crop, of which nearly two-thirds is situated in Bombay, Madras and the Central Provinces where its grain forms the chief article of diet of a large section of the population. As its dry stems (*kadbi*) also are largely used for feeding cattle when no green fodder is available, this crop plays an important part in the agricultural economy over large tracts.

In BOMBAY, considerable progress has been made in the isolation of promising pure strains from the best local varieties, and it will be possible to measure the likelihood of a big advance in the yield of *juar* types in next year's report. Two decided successes in improved cultural methods are also reported. The practice of repeated shallow hoeings for conservation of moisture during droughts has created considerable enthusiasm in the Ahmednagar District, while the adoption of ridge cultivation is extending in South Gujarat where the crop suffers from waterlogging in black soils.

The Millets Specialist in MADRAS continued his survey of the different types of plants represented in the crops of local varieties. Pollination studies have been begun as a preliminary to cross-breeding, and experiments to determine the extent of natural crossing during the *chitrai* season have been laid down.

The varieties of *juar* advocated by the department in the CENTRAL PROVINCES are Saoner, Ramkel and Lamkansi which give from 12 to 23 per cent. higher outturn than the *desi* races. The low vitality and germinating power of Chapti, which has a high reputation for eating purposes, tells against its popularity. Of the fodder *juars* grown on the Nagpur farm, No. 130 isolated some years ago is promising to do well.

The use of a solution of copper sulphate as a remedy for *juar* smut has now become a common practice, and it is estimated

that last year in Bombay alone seed for at least one-and-a-half lakhs of acres were steeped with successful results. Copper sulphate has the disadvantage, however, that the seed must be sown very shortly after treatment to avoid damage, and a fungicide which does not affect the vitality of the seed, for some time after treatment, would be distinctly preferable. Such a fungicide has been found in the Central Provinces in finely-divided copper carbonate, but a suitable apparatus has yet to be designed for thoroughly dusting the seed with the dry powdered chemical.

The ravages of *Amsacta moorei*, the Katra caterpillar which does enormous damage to all cereal crops in Upper Gujarat at the beginning of the rains, can be checked to a large extent by dusting with a mixture of Paris green and lime (1 : 20) at a cost of Rs. 2 per acre. This result has been confirmed over a large area during the year under review.

## XV. Ragi (Eleusine coracana).

The MYSORE department has found in H 22 a variety of *ragi* which is suitable for most *ragi*-growing areas of the State. The search for better types, both by individual plant selection and hybridization, however, continues. During the year varieties have been selected some of which yield more heavily, some which ripen earlier and some that are more resistant to drought than the popular H 22 which has already extended over 22,000 acres. These are being grown on larger plots to secure sufficient seed for distribution. On the Hebbal farm, the application of castor cake or ammonium sulphate distinctly increases the yield of grain and straw, while the addition of potash depresses it.

At a special research station at Hatkhamba in BOMBAY, one strain of *ragi* has been isolated yielding four times the amount given by the local type and twelve others which yield double. These will be tried on a larger scale before handing over to the cultivators.

Selection work aiming at raising the number of spikelets in an earhead on *ragi* is being done at the Hagari farm in MADRAS.

At Kalimpong in BENGAL, the open-loose variety has established its superiority over the close-headed variety during trials extending over last five years. Experiments are in progress to isolate better strains by pure line selection.

## XVI. Potatoes.

Of the many introductions from the West, the potato has perhaps achieved the widest popularity. It has become a regular item in the dietary of the middle and upper classes, and the area under this crop is being extended yearly in response to the demand for the produce. Climatic conditions will always militate against its spread to the scale on which it is cultivated in more temperate regions, but if the problems connected with the supply of seed and the control of disease are successfully tackled by the various departments who are interesting themselves in them, the cost of production can be so reduced as to bring potatoes within the reach of the poorer classes.

The acclimatization, testing and distribution of potato seeds continue to be the main feature of the programme of the Upper Shillong farm in ASSAM. In addition to the four previously selected strains, six new ones imported in 1921 were grown for seed. The system of issuing improved varieties to selected cultivators on the return system is being continued and 11·4 tons were issued on these conditions during the year. The cultivators return one-and-a-half times the quantity given for seed and keep the bulk for further propagation. The area under selected strains is steadily being extended.

The experiment of storing the summer seed in boxes conducted during the last five years has given fairly satisfactory results. To ensure not only a cooler but also a more uniform temperature throughout the season, small quantities of potatoes were stored last year underground, and the experience gained was encouraging.

The year's work at Neterhat in BIHAR gave further promise of establishing monsoon growing of potatoes on a firm basis on the Chota Nagpur plateau. A light dressing of superphosphate in the drills at the time of planting has been found to hasten germination and give a uniform stand. Manurial experiments

on the Sabour farm indicate that sulphate of ammonia can profitably replace much of the castor cake now applied by cultivators.

In MADRAS, 29 varieties, including 22 from England, five from Australia, and two seedlings raised on the Nanjanad farm, were tested. The results were not reliable, as the rainfall was deficient for the first crop, while damp conditions favoured early blight in the second. Experiments with different manures confirmed the benefit derived from the use of fish guano. Other improvements introduced are contour planting to prevent soil erosion during a heavy monsoon, wide planting to facilitate weeding and earthing up, and the use of a Turn-wrest plough which results in a saving of Rs. 11 per acre on cultivation expenses.

With the wider adoption of the practice of dusting with sulphur against the mite which causes the *tambera* disease in BOMBAY, the growing of potatoes in the *kharif* season on a much larger scale has become possible. Fumigation against the potato moth was also largely taken up during the year, when the attack of this pest was particularly severe. Investigations are in progress to find a more suitable type of seed potato; some of the recent importations from Scotland and the seedlings raised at Ganeshkhind are particularly promising. The solution of the question of storage through the hot weather being vital to putting the industry on a satisfactory footing, an attempt is being made to see if cold storage is applicable and economical under local conditions.

For the harvest of 1923, cold storage has been tried in the UNITED PROVINCES on an experimental basis by partial insulation of a godown supplied with internal refrigeration. The average temperature of the godown was brought to below 55° F. and potatoes were stored with a loss of less than 0·4 per cent. at the time when less than 16 per cent. of the control lot remained. On the field side, different types grown are being sorted out and tested for yield and resistance to mosaic disease which causes a large loss. In the course of these trials, a mixture of castor cake with a moderate amount of litter appeared to give the best results.

## XVII. Beans and Pulses.

A diminution of prussic acid content to about 30 per cent. has been achieved in some strains of the BURMA BEAN Pebyugale (*Phaseolus lunatus*) by single plant selection, but it is not possible to predict whether this work is likely to lead to the production of an acid-free bean. The problem is also being attacked in another direction. Several varieties of Japanese beans are being tested to find a suitable substitute. Of these, the most promising is a variety known as Kotonashi which yielded at the rate of 635 lb. per acre last year.

The cultivation of GRAM, which provides a useful rotation with wheat in heavy black clay loams of Burma, was in danger of being entirely given up on account of the ravages of *Fusarium* wilt, but the presence of a wilt-free variety known as Karachi gram on the Padu farm has saved the situation. An intensive campaign to distribute selected seed in the season 1922 resulted in increasing the area under the Karachi variety from 400 acres to 28,000 acres. In a couple of years more the local diseased variety should be completely ousted, and it is estimated that the increased value of the gram crop due to the change will be at least five lakhs of rupees per annum. In the meantime, various other varieties from India are being tested to keep in reserve as many disease-resisting types as possible.

In Bihar, Sabour Type No. 4 is establishing its superiority over the local grams, while some of the improved strains grown on the Nagpur farm produce about 33 per cent. more seed than the *desi* gram. Pusa types of gram are making good progress in the localities in which they have been introduced.

Varieties of SOY BEANS selected at Kanke in Bihar seem likely to make the cultivation of level uplands of Chota Nagpur an economic proposition. One, Black Early, gave a yield of 1,600 lb. per acre last year, which perhaps cannot be beaten by any other leguminous crop on the red upland soil.

In Bengal, varieties of *masur* (*Ervum lens*), *khesari* (*Lathyrus sativus*), and peas (*Pisum sativum*) have been classified according to colour of stem and flower, and different agricultural types isolated for comparative studies.

The cultivation of RED GRAM (*Cajanus indicus*) is rapidly extending in Burma, and to meet the demand for an early maturing red-seeded variety, 29 varieties imported from India are being employed at Mandalay.

In the Central Provinces, an attempt is being made to fix two distinct types, one early and the other late, which would suit the climatic conditions prevailing in different parts.

## CHAPTER III.

## RESEARCH AND INVESTIGATION.

Space does not permit of an adequate review of the large amount of research and investigation undertaken by the various Departments of Agriculture in India. Most of the investigations are still in progress and have not yet reached the stage at which the results achieved are of much interest to the public. Readers interested in any particular branch of research are referred to the Scientific Reports of the Pusa Agricultural Research Institute and to those of the provincial research officers which are published separately.

### I. Soils.

***Survey of Soils.*** Soil surveys are now in progress in Madras, Bihar, Bengal and Burma which, when complete, will yield valuable information for workers on soil problems all over India.

In MADRAS, the soil survey of the principal rice areas has been continued, and that of the Periyar was completed and published during the year. The latter reveals a striking deficiency of phosphoric acid over much of the area. A survey of Malabar soils is in progress.

A fairly complete soil survey of the different existing Government farms has been made in BENGAL, and a number of samples from districts not yet represented by farms have also been analysed. The scientific staff of the Indian Tea Association has completed the soil survey of the Mandaldai, Bishnath, Tezpur and North Lakhimpur districts, and the results have been published.

In BIHAR AND ORISSA, the soil survey of South Bhagalpur has been finished and the work has been extended across the south of Monghyr along the basin between the Kharagpur hills and the Barabar hills in Gaya. The paddy soils of the Saran District are giving indications of a fair percentage of available phosphoric acid which is not shared by the upland soils and those growing *rabi* crops.

The availability of phosphate in soils of BURMA for paddy crop different parts of Burma is being determined by a series of analyses.

***The "available" phosphate in calcareous soils.*** In connection with the investigation at Pusa on phosphoric acid in calcareous soils an endeavour was made during the year to discover a solvent which, whilst extracting an appreciable amount of phosphoric acid, is still not naturally affected by the presence of varying amounts of carbonate of lime. A large number of solvents of divergent character in their action on typical Kalianpur soils (which are rich in phosphate) mixed with incremental amounts of carbonate of lime were studied, and in the vast majority of cases it was found that this substance exerted a marked depressing effect upon the amount of phosphoric acid extracted. It was discovered, however, that extraction with solutions of alkaline carbonates very closely obeyed the conditions laid down, and in actual practice it was found that a 1 per cent. solution of potassium carbonate was the most convenient for general employment.

The availability of potash and phosphoric acid as affected by lime is being investigated on the Dacca soil. Applications of lime appear to have a definite effect on the organic complex, involving alumina, besides the common plant foods, such as potash, lime, phosphoric acid, etc. At first phosphoric acid appears to be rendered available, then beyond a certain point, potash is thrown out of solution. In view of the fact that both lime and potash are limiting factors in the cultivation of jute in this soil and that heavy applications of lime on the Dacca farm conduce to increased purity of sugarcane juice, further elucidation of this question is of great practical importance.

***Soil moisture.*** In the famine areas of the Bombay Deccan, the conservation of whatever small amount of moisture is precipitated in the soil is the dominant factor in crop production. Investigations have, therefore, been put in hand to determine the physical properties of the different types of soils and to find out means of increasing their water-holding capacity. Although no new developments are to be recorded, it is expected that

practical methods suitable for application will be forthcoming within the next two or three years.

***Soil aeration.*** In the study of the soil aeration factor in the case of plants grown in Pusa soil in lysimeters with free drainage, it has frequently been observed that in years of normal rainfall a decided falling off in permeability takes place after July. The soil refuses to drain, the pore spaces in the surface soil become suffused with water, aeration falls off and the absorbing roots die. Java indigo, for example, maintains itself during the late rains entirely by means of the surface roots and those which occur in the drainage layer on the floor of the lysimeter. This state of affairs appears to be associated with the formation of colloids in the soil and is always accentuated when the supply of organic matter needs renewal. Experiments have been in progress to test whether the well-known effect of superphosphates may not be due to their action on the colloids and whether other substances which act as weak acids may not produce similar results.

***Movements of nitrates.*** The study of the movements of nitrates in the soil and sub-soil with a view to their correlation with seasonal cropping variations was continued at Pusa on the lines laid down in last year's report. This year's observations tend to show that for the conservation of nitrates the best types of soil are those which possess a fairly heavy layer of a depth from three to four feet, and that from the point of view of nitrogen conservation the value of green-manuring during the earlier stages of the monsoon is open to question, owing to the rapidity with which the nitrate formed is carried down into the deeper layers of the soil.

## II. Nitrogen Fixation.

The work on nitrogen fixation in soil by non-symbiotic organisms is being largely developed at Pusa. A large number of experiments were carried out during the year to obtain further information as to the symbiotic relationship between algæ and nitrogen-fixing soil organisms, to test the effect of various organic residues and compounds upon nitrogen fixation in soil, to determine the relative rates of utiliza-

tion of dextrose by azotobacter, clostridium, *B. radicicola* and a mixed culture from cow manure, and to estimate the amount of nitrogen fixed in river silt, in cowdung alone and when mixed with straw, and in pure cultures of azotobacter to which small additions of nitrate had been made. Field experiments to determine the effect of various manurial and other treatments have also been commenced. The results hitherto obtained, although no doubt forming but a fraction of the greater mass of information which will be necessary for an adequate understanding of this important subject, serve to indicate that in time it should be possible to show in what manner the cultivation of the soil may be modified so as to increase the amount and rate of nitrogen fixation naturally taking place therein.

To elucidate the problem of the maintenance of fertility in unmanured soils, a series of determinations of nitrogen accumulation in wheat soils of the Jubbulpore *haveli* are being made at Nagpur. Two further series to compare the effect of growing wheat alone and wheat and gram together and the influence of the rotation groundnut followed by wheat upon the soil's stock of nitrogen have also been started.

## III. Manures and Fertilizers.

***Farmyard manure.*** As the result of further work on the activation of nitrification of cattle urine, a method of conserving its nitrogen content, suitable for use by the ordinary Indian cattle owner, has been worked out at PUSA. It consists essentially of the use of a suitably prepared aerating filter bed made of broken brick or rubble, the passage of the collected and diluted urine through this bed resulting in the formation of nitrates and recovery of the major portion of the original nitrogen content of the urine in this form.

In MADRAS, experiments on a large scale are being made to ascertain whether it is possible to devise a method of storage which is not too costly for the cultivators and which will reduce the loss of plant food to a minimum. Four methods are being tested :—(1) The box system, in which the manure is compacted

by the cattle themselves; (2) a pit system with urine trap; (3) the pit system with soil; (4) a heap method, in which no precautions are taken either to collect the liquid portions or to protect the manure heap. Preliminary analyses have shown that box made manure is richest in nitrogen.

The possibilities of producing " artificial farmyard manure " by fermenting waste organic matter are being investigated in Madras. Promising results have been obtained with paddy straw, but in the case of waste material such as prickly pear, lantana, etc., it has been found that the conditions of fermentation differ from those at Rothamsted and large losses of nitrogen occur in the process. In the CENTRAL PROVINCES, the leaves of the teak tree are being utilized for the purpose, and it has been found that as a result of the decomposition of this material in the presence of air and water a certain amount of nitrogen is accumulated. Samples of this artificial preparation are being tried on a small scale in comparison with ordinary cattle manure.

***Green-manuring.*** The continued residual effect of large applications of fermented green manure has been a marked feature of the returns of the permanent manurial and rotational plots at PUSA, and the effectiveness of such applications in conjunction with the use of superphosphate has been also most noticeable. The most remarkable result, however, has been the re-establishment, by a single ploughing in of a green manure, of the fertility of a series of plots " phosphated " five years ago which had to all appearance, through repeated cropping, dropped to a lower scale of fertility, the non-phosphated check plots showing no such results. The importance of the result from an economic point of view alone has led to the initiation of experiments designed to throw light on this interesting problem, with special reference to the possibility of bacterial intervention playing a considerable part in the matter. A field scale experiment confirmed the conclusions drawn from small plots in the previous season that in using *sannai* (*Crotalaria juncea*) as a green manure it might be advantageous to combine with this operation the separation of the stems as a source of fibre, the tops and leaves alone being buried in the soil.

A comparative examination of the value of different green manures is in progress in BENGAL. These experiments gave during the year valuable indications regarding the time at which green manure should be ploughed in in a wet climate like that of Dacca. This would appear to be at a markedly later date than would be necessary in a drier environment.

***Phosphate.*** The possibility of rendering the at present unavailable nitrogen of *mahua* (*B. latifolia*) cake and the phosphate of rock phosphate of service to crops is the subject of another investigation at PUSA. Detailed experiments previously carried out definitely showed that when the cake is composted with nodule phosphate and sulphur there is not only increased nitrification (40 per cent.) but 4·32 per cent. of phosphate is solubilized in sixteen weeks. Very great advances in the percentage of phosphate rendered soluble were made during the year by the use of cultures of sulphur-oxidizing bacteria; this was increased to 66·9 per cent. with one culture, and to 88·9 per cent. with another. An interesting observation was also made that additions of gypsum to the sulphur-phosphate compost increased solubilization by improving the physical texture of the mass with regard to aeration. Although it still remains to be proved whether even this cheapening by natural processes of the soluble phosphates will bring phosphatic manuring on a large scale into the region of practical politics, the importance of the process which eliminates the use of sulphuric acid is difficult to overestimate.

The permanent manurial plots at the COIMBATORE Central Farm were laid out in 1909, and have, therefore, now been under observation for 13 years. During this period, 36 crops have been grown, and the general conclusions drawn are that, after the first few years, phosphate has been more rapidly exhausted than nitrogen and has now become a limiting factor, that the percentage of phosphate in both grain and straw varies with the amount available in the soil, and that the proportion of grain to straw is raised by the application of phosphate. Nitrogen alone has been found to produce but a small increase of crop, nor does it influence the grain to straw ratio. The addition of potash has not had any consistent effect in the case

of sorghum or wheat but has materially increased the yield of the *ragi* crop both in grain and straw.

***Calcium cyanamide.*** Although the field trials made with calcium cyanamide in Madras have given somewhat conflicting results, it may now be definitely stated that there is no risk of toxic action from the use of this fertilizer, provided that it is evenly distributed and thoroughly incorporated in the soil. The most favourable results were obtained on garden lands with the *ragi* crop, where an application of one cwt. gave a marked increase in produce. On black soil a negative result was obtained with sorghum, but it was abnormal. A considerable number of field trials with this manure are being conducted this year on the various farms of the province.

***Gypsum.*** In connection with the study of the relationship of superphosphate manures to calcareous soils at PUSA it became of interest to determine the effect of gypsum contained in commercial supers on the cropping value of the soil. Pot culture experiments were laid down during two cropping seasons to test the effect of gypsum when applied alone or in combination with green manures or monocalcic phosphate. The residual effect of gypsum on the crop following that to which it was applied was also tested. As a result it was evident that gypsum exerted no beneficial effect, but on the other hand in the majority of cases it appeared to decidedly depress the yields. These results have also been confirmed on a field scale. It is probable that this action of gypsum accounts in some measure for the uncertain reaction of " super " when applied to the Pusa fields.

A study of the effect of gypsum on a tract of land containing a 3-foot deep layer of almost impervious soil on the Sabour farm in BIHAR has shown that the rate of percolation can be appreciably increased by the addition of 500 lb. gypsum per acre. In heavy low-lying soils its addition has been found to render soluble in water nearly double the usual amount of the soil constituents. After the first extraction, however, the soluble matters obtained were small and differed little in amount from a soil not treated with gypsum.

***Urea.*** Preliminary experiments made at Nagpur with urea tend to show that this highly concentrated manure will bear

comparison with nitrate of soda and sulphate of ammonia if it can be supplied at a satisfactory price.

***Lime.*** The results of the liming and manuring experiments at Jorhat in Assam, extending over the last 14 years, indicate (a) that no crop can be grown on the farm without liming either in the form of one heavy dose or several smaller doses; (b) that about two tons per acre slaked lime or ground limestone appears to be the appropriate quantity and that it is preferable to apply it in two or three doses at intervals; (c) that wood ashes added to cowdung very much improve the fertilizing quality of the cowdung; (d) that deep cultivation gives a better outturn with heavier doses of lime, and shallow cultivation on lightly limed area; (e) and that ordinary fertilizers, except basic phosphates, have no effect on the cropping in the absence of lime, and that sulphate of ammonia alone acts adversely whereas the addition of any base, *e.g.*, lime, magnesium carbonate or even sodium carbonate, produces heavier crops. Assam has unfortunately discontinued its Agricultural Chemist and it has not been found possible to proceed further with this work.

## IV. Sugarcane.

Experiments on the windrowing of cane under PUSA conditions were continued. They confirmed the conclusion previously arrived at, that canes stored under protection remain in excellent condition, whereas those stored in the open and exposed to rain and sunshine rapidly deteriorate. The results obtained indicate the possibility of storing canes in Bihar provided suitable precautions are taken.

In conjunction with this investigation a study has been made regarding the nature of the enzymes inducing deterioration of windrowed canes and the mechanism through which their activities become effective. It has been found that these enzymes are localized in certain portions of the cane, particularly in the nodes, and normally do not affect the juice contained in the internodes. The effect of rain in contact with a somewhat dry windrowed cane is to bring about a translocation of these enzymes into the internodes and thus induce deterioration.

Observations carried out at SABOUR for three years on the periodic juice analyses of sugarcane grown on the Ranchi farm indicate that climate has a striking effect on the ripening of sugarcane. In 1920 the cane ripened in the third week of December, while in the next two years it was not found to be mature until the second week of February or nearly two months later. The abnormally early ripening of the canes in 1920 is ascribed to a sharp drop in humidity in the third week of November which was not recovered until well on in January : in the other two years there was no such drastic period of drought.

Investigations have been started at PUSA to determine the character and specific action of various organisms found as contaminations in the cane juice of sugar mills in Bihar. A constant small percentage loss of sugar occurs in the mill, part of which is probably due to inversion during the short time of passage from the rollers to the evaporating plant. It appears probable that some degree of antiseptic precaution in the mill would be attended with advantages.

## V. Sugar-beet.

An investigation has been carried out at the Tarnab farm, Peshawar, in collaboration with the Pusa Institute, into the effect of (a) irrigation, (b) storage of mature roots in pits, and (c) seeding of mature roots on the quality and quantity of sugar-beet juice. The results are being compiled for publication.

## VI. Indigo.

Further work at Pusa on vat fermentation of indigo has shown that in cases where fermentation is poor, settling bad and produce low, neutralization with caustic soda before beating should result in improved settling and an increased yield of indigo. A considerable amount of work was also done on the subject of sterilization of indigo paste. Numerous bacteria were isolated from paste in a fermenting condition, some samples of which had been imperfectly sterilized in England with paranitranilin and others by heat. The thermal death point of these was determined and recommendations as to appropriate methods of sterilization by heat were made.

## VII. Preparation of Malt from Sorghum.

Work was continued at Coimbatore with sorghum in order to ascertain the conditions of malting leading to a malt capable of giving a high extract. The best of the 18 varieties examined gave practically the same extract as the barley used as a control. The conditions determining this result are: (1) steeping for 36-48 hours before germination; and (2) slow germination with a steady but moderate moisture supply. The high fat content of the sorghum grain has a detrimental effect on the resulting malt, but the amount of fat can be considerably reduced during the malting process under suitable conditions. There is no reason why sorghum malt should not replace barley malt especially in the production of malted foods, and the Industry Department, to whom this work has now been handed over, is considering the feasibility of starting a small pioneer factory.

## VIII. Animal Nutrition.

Investigations on animal nutrition were begun at Pusa in 1921 with a study of the digestibility of some of the more common of Indian fodders. The past year's work with rice straw gave some interesting results. The average digestion co-efficients found for fibre and nitrogen-free extract were 72 and 44, respectively, which figures, when compared with the results obtained from similar experiments carried out in America, indicate that the country-bred bullocks under trial at Pusa digest 10 per cent. more organic matter than American breeds. To carry out nitrogen metabolism determination with ease and accuracy, a new apparatus has been designed by the use of which urine can be collected quantitatively for long periods without inconveniencing or tiring the animals. With the transfer of the Animal Nutrition Section to the newly established Imperial Institute of Cattle-breeding and Animal Husbandry at Bangalore, the scope of its activities will, it is hoped, be considerably developed.

## IX. Lathyrism.

The botanical work in connection with a detailed investigation, under the auspices of the Indian Research Fund Associa-

tion, of that form of paralysis known as lathyrism was continued at Pusa during the year. No evidence has hitherto been obtained in favour of the current view that the disease is due to the long continued consumption of the seeds of *khesari* (*Lathyrus sativus*). Not only the various isolated unit species of *khesari* are grown in pure culture, but an intensive study is being pursued of the several leguminous weeds which occur mixed with it.

## X. Beriberi.

A promising start has been made at Coimbatore, in association with the Medical Department, with a chemical investigation into the causes of beriberi. The results obtained during the year point to the conclusion that the incidence of the disease is closely linked up with the method of treatment which rice receives before it is used for food.

## XI. Diseases of crops.

The practical methods adopted for combating the ravages of diseases attacking the more important crops have been indicated in the previous chapter. It is proposed to deal here with such investigations as have not reached this stage.

At Pusa field experiments were laid down to control smut on *bajra* (*Pennisetum typhoideum*) and downy mildew of maize, but no definite conclusions could be drawn as the incidence of both diseases was slight. This is remarkable as the monsoon was a heavy one with few breaks so that the humidity remained continuously light, yet the temperatures were uniformly lower, and this latter fact probably accounts for the mildness of this disease.

The foot-rot of wheat is also under investigation at Pusa. Of various fungi isolated from wheat plants affected by this disease, one, a species of *Helminthosporium*, was shown to be able to destroy wheat seedlings. This is probably the cause of the disease but much work still remains to be done on the other fungi invariably found associated with it on affected wheat plants. Foot-rot is said generally to be found in those fields which have been sown early : it is, therefore, possible that in areas where it causes much loss if the sowing were delayed till the cold weather has really set in there would be very little trouble.

The two plots laid down to determine the influence of sodium sulphate on the growth of jute and the incidence of disease showed marked differences. The manured plot contained 1,399 plants weighing 533 lb. and disease was entirely absent, while, on the control plot, of the 1,342 plants weighing 220 lb. 744 were diseased. So promising is this result that a more extensive series of field experiments have been laid down to test the accuracy and applicability of this treatment. The influence of the composition of the soil upon the incidence of disease in jute is also being studied in cultures designed to test the effect of certain constituents of the soil on the growth of the fungus in culture.

In MADRAS, besides the diseases caused by species of *Vermicularia* on turmeric, cabbage and gram, a disease which causes the shedding of leaves of sorghum is being studied. Soil infected with spores of *Sclerospora graminicola* produced during the year a crop of diseased sorghum plants indicating the means by which the disease is carried over.

In BOMBAY, the storage rots of potatoes, cotton wilt, and leaf spot and blight of onion are under investigation. With a view to see if cold storage is applicable and economical under local conditions, the temperature relationship of the four most common potato rot fungi is being studied. The application of sodium nitrate in small doses at intervals combined with the practice of " rabbing " has been found beneficial in checking the leaf spot and blight of onion, while some varieties resisting the disease to a considerable extent have also been found. Similarly it has been ascertained that there are types in both Kumpta and Broach cottons which resist wilt better than others. Field experiments carried over several years have shown that smut of *ragi* is not seed-borne and that seed-treatment with copper sulphate is of little effect.

Very satisfactory results are reported from the UNITED PROVINCES with the experiments on storing seed and food potatoes at low temperatures. The wilt of safflower and a serious nematode disease of wheat are other diseases engaging attention in this province.

In BENGAL, the morphology of several fungi associated with a disease of betel-vine is being studied, while in ASSAM, experi-

ments have been begun to find a preventive for a disease caused by a species of *Cephalosporium* on rice plants.

## XII. Insect Pests.

The measures adopted against important pests of field and garden crops have been referred to elsewhere and need no recapitulation. A large amount of useful observations relating to the life-histories and behaviours of other insects known to affect crops and of their parasites have also been made at Pusa and by provincial workers, and these are referred to below.

At PUSA the investigation on borers in sugarcane and other gramineous plants indicates that previous work on species occurring around Pusa had been fairly thorough. Cotton plants sown in 1921 were kept under observation until up-rooted in June 1923, especially to ascertain whether an abnormal shedding of bolls had any connection with the presence of certain bugs on the plants, but further research is required to make a definite statement on the subject. Investigation of fruit pests, especially *Aspidiotus perniciosus*, in Kashmir was taken up towards the close of the year.

Work on pathological entomology was continued mainly with reference to veterinary entomology, with regard to which there appears to be need of a publication dealing with the insect pests of domesticated animals in India. Considerable progress has been made in the preparation of a book on these lines. Special attention has been paid to Tabanidæ, from both the systematic and biological aspects, and further work has also been done on the biology of the local Culicidæ. In collaboration with the Imperial Bacteriological Laboratory, experiments were commenced at Muktesar on the cyclical transmission of rinderpest organism.

The trial of the control of *Siga* (*Schœnobius*) *incertellus*, the paddy stem borer, by the method of seed selection was continued in MADRAS, and an investigation was begun of the bionomics of *Calocoris augustatus* on sorghum. Manurial experiments are also in progress to check a disease in betel-vines due to the attack of the root-knot eel-worm.

In BOMBAY, a detailed investigation is being made into the borers attacking sorghum through the help of the Sir Sassoon David Trust Fund. Sorghum sown at Surat from the middle of July to the middle of August was less attacked by the borers in the initial and middle stages of the crop and resisted borer attack better during the ripening stage, in comparison with earlier and later sowings. No varieties were found immune from attack. The borers were found to breed in sprouts from stubble left in the ground, but breeding is stopped if the stubble is ploughed up and exposed to the sun's heat for about two weeks in the summer. Larvæ of *Chilo* are able to survive in *kadbi* stalks stocked for cattle fodder but are killed by fodder chaffing. At Poona, the parasites of *Chilo*, of which one was found attacking the egg, three the larva and two the pupa, were studied. In the Konkan work was done on crabs injurious to the rice crop and on the protection of cruciferous seedlings from flea-beetles.

The percentage of attack by *Chilo* in six varieties of sorghum grown in the CENTRAL PROVINCES ranged from 25 to 67, the lowest being in Ramkel. *Xanthopimpla nursei* has so far appeared to be a common parasite on this borer pest.

In addition to work on cotton, sugarcane and fruit pests, investigations into methods of protecting stored grain from weevil attack are in progress in the PUNJAB. Experiments on air-tight storage have not so far yielded results of practical utility, but super-heating has proved to be a very effective and economical way of " cleaning " insect-infested godowns. A systematic use of poisoned baits over large areas coupled with co-operating action has been found the best and cheapest means of rat destruction.

An interesting principle of control of hard-bodied insects with soft-bodied larvæ has been discovered in MYSORE, and efforts on the lines suggested by it are now being directed against *Oryctes rhinoceros*. The presence of mercury in a small muslin bag hanging from the lids of jars containing pickles has been found effective against pickle-flies (*Drosophila* sp.).

In TRAVANCORE, a detailed study is being made of the life-cycle of the rice swarming caterpillar (presumably *Spodoptera mauritia*).

## XIII. Useful Insects.

***Bees*** The Entomological Section at Pusa continued to deal with inquiries regarding bee-keeping and supply improved hives, foundation comb, etc. The subject of apiculture in India requires the services of a whole-time expert in this line if work is to be taken up seriously. That there is a large demand in India for honey is certain, and it is no less certain that the demand could be met if bee-keeping on modern lines were taken up.

***Lac.*** The demand for supply of brood-lac continues and as much *ber* (*Zizyphus jujuba*) brood-lac as could be spared was sent out from Pusa. The October crop was heavily parasitized by a Chalcidid which was studied. An investigation has also been started into the damage done by the Noctuid moth (*Eublemma amabilis*) which completely wiped out last year some of the experimental plantations in the Central Provinces at a time when the crop had been growing vigorously on the trees.

***Silkworms.*** The work on hybridization of silkworms has been abandoned in BENGAL as it seemed to have very little prospect under the conditions prevalent in the province. All activities will, therefore, be directed in future in the direction of the improvement of the local races by selection. It has also been decided to close two of the hill nurseries and concentrate all the work at Kurseong, which will be mainly concerned with the rearing of the Chotapolu silkworm which is a more delicate race and more susceptible to the attack of pebrine than the Nistari worm.

The multiplication and distribution of " examined " seed is the main item in the sericultural policy of the Bengal Sericultural Department. Examined seed of the value of Rs. 61,188, as against Rs. 79,381 in the preceding year, was issued from the six nurseries maintained for the purpose. The falling in receipts is attributed mainly to the shortage in cocoon production resulting from unfavourable weather conditions. The private seed production organized by Rai Saheb A. C. Ghosh, to act as an intermediary agency between the Government nurseries on the one hand and the commercial cocoon growers on the other, is developing, and the sales made by selected rearers, most of whom are ex-students of sericultural schools, amounted to 8,369 *kahans* of

cocoons compared with 4,000 in the previous year. It is also satisfactory to note that several combinations of capitalists have started seed-growing concerns.

Ten students passed out the Berhampur and Rajshahi sericultural schools : they will be given this year rewards of Rs. 250 each for the construction of rearing houses and will be registered as selected seed-growers. There were 19 and 26 students respectively in the primary classes attached to the Piasbari and Amriti nurseries.

With the transfer of the sericultural work to the Industries Department in MADRAS the original scheme for the development of the industry in Kollegal taluq of the Coimbatore District has been considerably modified. The new proposals contemplate the closing of the Singanallur demonstration farm; in its place a peripatetic rearing party is to be brought into existence, with its headquarters at Singanallur, to instruct villagers in sericulture, to distribute disease-free seeds obtained from Coonoor among the rearers and to conduct experiments in improved methods of reeling silk. In the second place the hill-farm at Coonoor is to be expanded into a central distribution station for eggs or seeds, seed-cocoons, cuttings or seedlings and into a research institute for the silk industry of the presidency under the direct supervision of the sericultural assistant. The new proposal includes the deputing of a sub-assistant to the various localities outside the Kollegal taluq, suited to the purpose, to assist private persons in the selection of suitable land for mulberry plantations and in planting and weeding, etc. Government has already accepted the first of these proposals and has sanctioned the other two with certain limitations.

All attempts to introduce Indian races of silkworms have failed in BURMA.

Experiments are in progress in MYSORE to fix new and more productive races with all the best qualities of the local silkworms. Earlier maturing is also a desirable quality. In addition to nearly 4 lakhs of layings issued from State grainages, six millions of seed-cocoons produced by selected rearers were available for distribution.

In TRAVANCORE, both Government silk farms had a successful year. With a view to encourage silk-rearing among the depressed classes, it has been decided to assign to 30 individuals 5-acre plots of waste land for cultivation of mulberry.

## CHAPTER IV.

### AGRICULTURAL ENGINEERING.

In a country circumstanced such as India where the failure of the monsoon is considered the greatest national calamity that could happen, any agency that helps in increasing the controllable water supply is bound to be widely appreciated. The engineering sections of the Agricultural Departments, therefore, started with the initial advantage of having a mission to which no converts were to be made, and in the short period of their existence have been instrumental in increasing the capacity of thousands of existing wells and in digging or sinking an equally large number of new wells (Appendix III, p. 124). With the provision of an adequate and properly trained staff, the future potentialities of this useful work are equally great, for, even if every scheme recommended by the Irrigation Department is put into execution, there will still remain large tracts of the country where the principal limiting factor in crop production will continue to be water supply which, so far as can be seen, can only be met by developing and increasing the supply from wells by subartesian bores.

The introduction of improved implements has not proved so simple, for the reason that designs had to be specially prepared for India. The question of cost has also been a serious factor. The adoption of types suitable from the points of cost and draught power required is, however, proceeding satisfactorily (Appendix IV, p. 125). A large private trade in these implements has also grown up; one Indian manufacturer recently informed the Tariff Board that his factory annually consumed 8,000 tons of steel. Now that the existing engineering sections in the Agricultural Department are being strengthened and new ones are being created, the designing of cheaper and more suitable implements has become a matter of time, and it can be confidently expected that some of the promising designs now under trial will meet the requirements of the Indian cultivator.

The expansion and reorganization of the engineering section in the **United Provinces** has made it possible to meet the

growing demand for tube wells and pumping installations. At the close of the year, 16 installations were erected and completed with four pumping stations, while 18 more were in course of construction. Of the 624 shallow borings made, 457 were successful, a percentage of 75·23. The engineering section is also carrying out tests with certain new and modified water lifts for hand power.

In the **Punjab,** the number of bores sunk amounted to 301 of which no fewer than 245 or 80 per cent. of the total were successful. The corresponding figures for the previous year were 344 and 287.

The demand for the Mansfield water finder to locate sites for digging wells continues to be on the increase in the trap area of the **Bombay** Presidency for which it is specially suitable. This year charges were made for the services of the man and machine. The work of the boring plants is now being appreciated by the District Boards who are offering to maintain them.

In **Madras,** the Agricultural Engineer has designed a *gur* boiling furnace which is working successfully. The improvement of the country plough, trials with two ploughs of his own make, and the manufacture of a new type of bullock-driven sugarcane crushing mill are other subjects engaging his attention. Two hundred and seventy-eight wells were successfully bored by the Industries Department to whom this work has been transferred.

The implements designed by the Agricultural Engineer in the **Central Provinces** and sent out for extended trial include an intercultivator for cotton, a lifter for groundnuts, a spring-toothed harrow and a disc cultivator. In addition to these home made implements, an oil engine of a very simple type, a stubble breaker, a new design of disc plough, a sub-soiling plough and a water lift, all imported, are being tested to prove their suitability to local conditions. Of the 21 shallow bores made, six were definitely unsuccessful.

In **Bengal,** an officer of the Irrigation Department has been placed at the disposal of the Agricultural Department to advise upon, to help, to prepare, and to put into execution small

schemes of irrigation such as can be carried out under the Bengal Agricultural and Sanitary Improvements Act of 1919. A large scheme for flushing 100 square miles of country in Jessore and a still larger one for Murshidabad and Nadia Districts are under contemplation.

In addition to the 114 borings sunk during the year in **Bihar** as against 73 in the previous year, 45 old bores which had silted up were cleared. Arrangements are being made to obtain or manufacture cheap bullock power pumps which would be suitable for owners of small holdings.

The Agricultural Engineer in **Burma** constructed during the year a *jaggery* furnace capable of working on megass alone. A new share which can be fitted on to the ordinary Burmese plough has also been designed. This costs Rs. 4 only and is reported to do as good work as some of the European ploughs costing Rs. 40 or over.

In the **North-West Frontier Province** a new five-tooth spring-tined harrow with stilts and a guiding forewheel is being introduced.

The **Mysore** department has put on the market a new steel bar suited to the ordinary cattle plough.

A cheap and improved type of iron plough suitable for local conditions is being manufactured in the workshop attached to the agricultural school in **Travancore.**

Out of 40 bores sunk during the year in **Baroda,** 33 were successful; in **Hyderabad** the latter number was 17.

**Motor tractors and ploughs.** As was prophesied in the review for 1919-20, the case of the agricultural tractor has now proved so simple as it looked at the moment, and the task of deciding upon suitable types has been rendered more difficult by the impossibility of obtaining essential spare parts whenever a breakdown occurs. It is quite apparent that, unless agents are prepared to organize repairing centres, the limited motor tractor trade which has recently sprung up in India will disappear.

At PUSA, the two four-wheeled types tried have proved too low-powered for deep ploughing, but they are extremely useful for light and shallow cultivation with disc harrows or culti-

vators and cover large areas in a working day. After inclement weather when a large area of land has to be dealt with for *rabi* sowing in the minimum time they are invaluable, but the liability to break-downs, and subsequent delays through failure to obtain essential parts, detracts very considerably from the advantages gained.

Experiments in BOMBAY have shown that motor cultivation can only be useful when the unit area is 20 acres or more, and hence it is not applicable over most of the presidency. The earlier trials have shown the lighter types unsuitable for black soil areas, and it is proposed to have tests on some scale this year with heavier designs, both in Gujarat and Khandesh, where the department is offering to plough land at a definite rate.

The tractors on the Coimbatore farm in MADRAS have been found unsuitable for deep ploughing, and have been diverted to haulage of materials and running of agricultural machinery.

Two tractors of the caterpillar type in use on the Nagpur farm in the CENTRAL PROVINCES give very good service, and the average cost of the different agricultural operations was considerably reduced from that of previous year. These tractors were sent out on hire within a radius of five to six miles of the farm, and a number of landholders took advantage of the opportunity to get their fields cleaned and ploughed.

During the months of November 1922 to May 1923, a gang of tractors was organized to do ploughing on contract in the Nagpur Division. The prices charged ranged from Rs. 16-8 to Rs. 20 per acre, and some very bad pieces of land were tackled.

## CHAPTER V.

## DISTRICT WORK.

The value of this department to Indian agriculture is to be judged not only by the various research activities detailed in previous chapters, but also by the degree to which results can be transferred to the fields of the cultivator. How this can best be done has ceased to be a problem, and with a larger and better trained staff the Agricultural Departments are beginning to find that successful propaganda work is merely a matter of organization. The different provinces are, therefore, no longer engaged in search of " the best methods of getting into touch with the cultivator," but are devoting their energies towards the creation of an organization, best suited to local conditions, for meeting the evergrowing demand for better seeds, implements and manures. This organization, which started with only a few departmental seed and demonstration farms, now embraces the activities of hundreds of co-operative societies, private seed farms and demonstration plots, agricultural associations, court of wards estates and district boards, and in some favoured tracts the private seedsman of western countries has also arrived. The success with which this complex machinery has brought millions of acres under crops originally selected by the officers of the department and thousands of iron ploughs and cultivating implements into daily use will be evident from Appendices I and IV (pp. 109 and 125).

The changes introduced in the organization for district work in **Bombay** in 1921-22, *viz.*, a definitely closer co-operation between the Agricultural and Co-operative Departments, the institution of divisional boards which control the propaganda activities of both departments and the definite adoption of a system of local development associations for the carrying on of agricultural propaganda in areas which desire it, have been developed during the year under report. All the six divisional boards have been found so useful that in four cases the functions of the boards have been enlarged. The scheme of taluq

agricultural associations has also been taken up with such enthusiasm that eleven bodies were at work before the end of the year and 12 more were recommended for subsidy by the boards concerned. There is now a wealth of material for propaganda purposes, and the new organization based on popular support should go long way in furthering the aims of the department which are first and all the time to improve the quantity and quality of agricultural produce. Seed sufficient to sow nearly two lakhs of acres with improved varieties of crops was issued during the year from farms under the control of the department.

A most satisfactory feature of district work in **Madras** was the wide extension of the system of establishing demonstration plots in the ryots' own lands. It is the ideal method of convincing the farmer that there is not " a catch somewhere ", and there can be no more eloquent tribute to the work of the department than that land is freely offered for such demonstrations. The distribution of seed of selected strains of different crops was carried out, both through the agency of the department and the co-operative seed unions, as successfully as in previous years, and the areas sown under the three important crops of paddy, cotton and sugarcane were, respectively, 88,000, 62,000 and 2,500 acres. The use of green manures on wet land after the harvest of paddy occupies a prominent place in the extension work of this department, and 42 tons of sann-hemp, *dhaincha* (*Sesbania aculeata*) and *kolinji* (*Tephrosia purpurea*) seed were sold to cultivators during the year under review. A systematic campaign conducted in selected areas resulted in the erection of 114 Sindewahi *gur* furnaces and sale of 613 iron ploughs. District demonstrations on the value of concentrated manures have succeeded in creating such a demand that Messrs. Parry & Co. have been induced to open branch depôts in the mofussil. The spraying of garden crops against various diseases and the use of copper sulphate as a preventive against sorghum smut are two other lines of work in which popular recognition is visibly manifest.

Fifty-seven private seed farms to supplement the work of seed supply by Government stores and farms were in operation in **Bengal,** yet the demand for improved varieties of jute, paddy

and sugarcane was found to be several times the available supply. The available fifty tons of jute seed were disposed of in a fortnight at remunerative prices, the seed store at Dacca having been besieged every day by as many as 200 cultivators, some of whom had travelled more than a day's journey to get the genuine article. The department distributed over 150 tons of *rabi* seed, mostly on loan, in the districts devastated by the heavy floods of September 1922, and the high quality of wheats and pulses given out was much appreciated by the distressed cultivators.

Several khas mahal and court of wards estates and district boards continued to supplement the activities of the department by allotting grants both for distribution of seeds and manures and for employment of demonstrators. The awakening of enlightened public interest in agricultural improvement is further evident from the fact that some of the old moribund agricultural associations are apparently now keen to make up for their past sins of omission, and a new type of association working on co-operative lines is coming into existence. The only one of the latter which has worked for a whole year had made a profit on the farm started to demonstrate cultural improvements and to produce seeds of selected crops for the members.

In **Bihar and Orissa,** in addition to the distribution of Kakya Bombai jute, Dahia paddy, groundnut and Coimbatore canes 210 and 213, the demand for which is described as spontaneous and irresistible, such operations as the cultivation and ploughing in of *dhaincha* as a green manure for paddy, the manuring of groundnut with gypsum and of potatoes with castor cake combined with sulphate of ammonia, the drainage of sugarcane fields, and the construction of high level bunds in hilly tracts, are being demonstrated. Co-operative societies continued to take an active interest in the distribution of recommended seeds and manures. The provision of sugarcane mills and pans is being taken up by the Central Banks.

The whole situation as regards seed supply in the **United Provinces** has been reviewed and an organization evolved which should ensure the maximum distribution at a price consistent with financial stability. During the year under review.

about 1,800 tons seed of improved varieties was issued from Government depôts, wheat contributing half the amount. Over 1,600 implements and 2,400 spare parts and 80 tons of organic manures were also sold through the same agencies: the demand for these was nearly double of that of the previous year. A feature of the district organization in this province is the establishment of private farms by wealthy zemindars. The number of these farms has risen from 300 to 360: 34 of them are of 100 acres and over. They serve not only as seed depôts but also as centres from which improved methods spread to surrounding cultivators. Co-operative societies, district boards and court of wards estates are other organized units through which the extension work is carried out.

In the **Punjab,** there is a cotton and wheat seed depôt for improved varieties in each circle, with sub-depôts at convenient centres. Seed sufficient to sow 86,231 acres of wheat and 155,435 acres of cotton was sold from these depôts during the year. There also exist similar stores for the sale of improved implements of which no fewer than 4,035 whole articles and 709 spare parts were disposed of.

In the **Central Provinces,** 14 departmental and 2,588 private seed farms were at work, from which cotton, rice, wheat, sorghum and sugarcane seed sufficient to sow 446,730 acres, as against 389,985 acres in the previous year, was distributed. As the result of an intensive campaign for the spread of improved implements, the number sold nearly doubled. The district staff carried out 1,432 practical demonstrations and gave 77 illustrated lectures. The growing spread of the single-seedling method of transplanting rice, wheat irrigation and the adoption of the McGlashan *gur* furnace is attributable to this propaganda.

In **Burma**, about 180 tons of pure strain paddy, 133 tons of wheat, 50 tons of groundnut, 156 tons of gram and a large number of sugarcane sets were distributed. A new development was the organization of 45 private and co-operative seed farms to extend the work of seed distribution. Several township committees have been formed composed of prominent landowners and farmers with the object of discussing agricultural problems

with officials of the department, but it is doubtful whether this form of agricultural extension work is likely to bear much fruit.

Seeds, manures and implements of the value of Rs. 63,000 were issued from the three depôts in **Assam.** The most important of the articles supplied were 76 tons of Shillong potatoes, 52 tons of bonemeal, and 200 sugarcane mills. Successful demonstrations were carried out on cultivators' holdings in several parts of the province with improved Shillong potatoes, selected strains of paddy, superior varieties of sugarcane and with water hyacinth ash and fish offal as manure for jute and potatoes. The number of honorary correspondents, who were of considerable use in popularizing various improvements, has increased to 42.

Seed of Pusa 4 wheat and of berseem was distributed in the **North-West Frontier Province** as far as the resources of the Tarnab farm would allow. Nearly 50,000 fruit trees, chiefly peach, plum, pear, apricot, orange and pomegranate, will shortly be ready in the nurseries for distribution.

Co-operative societies are being largely utilized in **Mysore** for distribution of large quantities of seeds of *ragi* (*E. coracana*), cotton, sugarcane and groundnut, commercial fertilizers such as oil-cakes and sulphate of ammonia, and improved implements. Fifty-eight societies are at present interesting themselves in this work which in course of time the department hopes to be wholly relieved of.

In **Travancore,** in addition to 10,246 lb. of selected seed, sets of different varieties of sugarcane and tapioca and selected coconut and *robusta* coffee seedlings were sold either direct or through seed unions. Two well established companies have sprung up at Alleppey to meet the demand for fertilizers recommended by the department. The major portion of the wet lands in South Travancore has been brought under single paddy seedling transplantation, and no less than 3,000 acres of *punja* rice lands which would ordinarily have lain fallow during the year were cultivated by adopting the methods recommended by the department.

Varieties of cotton selected on the Surat farm by the Bombay department are spreading rapidly in the adjoining **Baroda**

territory, over 130 tons of seed being distributed from six State depôts. As the result of intensive propaganda, the use of ammonium sulphate has become established and people are now making independent arrangements for its supply.

The main feature of work in the **Hyderabad** State was the distribution of pure seed of the long-stapled Gaorani cotton on the takavi system. It is estimated that nearly four lakhs of acres were grown from this pure seed in five taluqs of the State.

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## CHAPTER VI.

## AGRICULTURAL EDUCATION.

Agricultural education, especially in its higher stages, has been considered the special province of the Agricultural Department from its earliest days, and agricultural colleges were thought of as soon as the department began to function in each province, and were made the central part of each provincial scheme. The dual rôle assigned to the colleges of training men for employment in the department along with those desirous of turning their instruction to practical account in private farming and estate management was responsible for not a little confusion. To overcome the difficulty, it was decided in 1913 to abandon the standard curriculum and to allow each province to work out its own salvation by framing its scheme of agricultural education with reference to the stage of general educational development and agricultural research that may have been reached. This laissez-faire policy, though much criticized at the time, has led up to the present situation where three of the five institutions now working teach up to the university standard.

Since 1917, the department has also been engaged in experimenting with various types of agricultural middle schools, but the results are by no means encouraging except perhaps in Bombay where the first school had already been opened. Even in Bombay it is impossible to multiply indefinitely schools of this type which annually cost about Rs. 200 per student, and it is likely that the task of adapting education in rural areas to rural needs will have to be eventually left to the Education Department as has been done in the Punjab where the Agricultural Department only assists in the way of training school teachers. A finishing touch to the training of these youths from the ordinary middle schools with an agricultural bias can be given by a short practical course on the farms, and it is in this direction that the educational activity of the department would probably be most fruitful.

For **higher agricultural education**, in addition to the Agricultural Research Institute at Pusa, which provides facilities for post-graduate courses, there are agricultural colleges at

Poona, Lyallpur, Coimbatore and Nagpur (Appendix V), and it is proposed to shortly open provincial institutions at Dacca and Mandalay to serve Bengal and Burma.

During the year under review, the maximum number of students admissible to the AGRICULTURAL COLLEGE POONA had to be reduced to 170 owing to the lack of staff and equipment. The results of the university examinations were on the whole satisfactory. Out of 45 candidates for the degree of B.Ag., 38 passed.

THE AGRICULTURAL COLLEGE AT LYALLPUR continues to provide two distinct courses, *viz.*, (1) the four-year degree course which is subject to university rules and regulations, and (2) the two-year leaving certificate course. Since the affiliation of the college to the university the standard of the candidates for admission continues to improve. This year, out of about 300 applicants only 53 could be admitted on account of shortage of accommodation. In all, thirty students qualified for the degree of B.Sc. and the college certificate.

Two courses of instruction are provided at the AGRICULTURAL COLLEGE AT CAWNPORE—the diploma course of four years and the two-year vernacular course to assist the youthful zemindar who has not attained a sufficient educational standard to benefit from a course in English. The demand for both types of education continues unabated, and the applications for admission being almost three times the number of vacancies, it is always possible to select really suitable candidates. Eight students obtained the diploma this year as against five in 1921-22, and 27 candidates, compared with 17 last year, obtained the certificate.

The institution is still in a transition stage as the result of the acceptance by Government of the recommendation of the Hopkins Committee that it should be affiliated to the Allahabad University. The practical steps that have to be taken to carry into effect that proposal are still the object of discussion.

With the closing down of the fourth class of the old diploma course in December 1922 and the degree course having made up the full complement of three classes for the first time, the AGRICULTURAL COLLEGE AT COIMBATORE is now fairly on its new course.

Out of 126 applicants for admission to the degree course, a full first-year class of 20 was formed. Eight candidates qualified themselves for the degree of B.Sc.Ag. at the university examination held for the first time.

The difficulty of obtaining students for the certificate course mentioned in last year's review continued to be felt, and there was again a falling-off in the applications for admission, the number being 88 as compared with 95 last year and 252 in 1920. It is, however, satisfactory to note that the intellectual attainments of 27 admitted this year were better than that of the 23 recruited in 1921-22. Nineteen students appeared for the certificate examination and 16 passed.

THE AGRICULTURAL COLLEGE AT NAGPUR has, after many changes, now defined its courses, and in the year under report provided education for six distinct classes. For students who have attained the matriculation standard the four-year diploma course is open, while a lower standard in the form of a college entrance examination is accepted for students who intend only to take the college certificate after two years' training. The certificate is also awarded to such students of the diploma course who at the end of the second year do not qualify for admission to the second part of the course.

Of the 75 students on the roll during the year, three held stipends from the Bihar Government and three were supported in a similar way by the Assam Government. As the result of the final examination, five obtained the diploma and nine were sent out with the certificate.

After the examination held in March 1923 in which 25 out of 26 students obtained the certificate, the AGRICULTURAL COLLEGE AT SABOUR has been closed down. This decision was arrived at in view of the poor demand for agricultural education among the people of the province, and the Bihar Government now sends stipendiary students to the Cawnpore and Nagpur Agricultural Colleges to qualify for admission into the lower branches of the department.

With the abolition of the Sabour College, there is no institution in the three provinces of Bengal, Bihar and Orissa, and

Assam, with a united population of 90 millions, to impart higher education in agriculture, and the establishment of the proposed AGRICULTURAL INSTITUTE AT DACCA has now become an imperative necessity. It is to be hoped that financial conditions will allow of a speedy realization of the scheme.

Good progress has been made with the erection of the AGRICULTURAL COLLEGE AT MANDALAY, and it is expected that teaching will begin in June 1924.

Eleven post-graduate students were under training at the AGRICULTURAL RESEARCH INSTITUTE AT PUSA during the year: three in general agriculture, one in economic botany, two in mycology, one in economic entomology and four in agricultural bacteriology.

With the object of developing the post-graduate training at Pusa to the highest possible standard, a scheme for the expansion of the Institute as regards staff was sanctioned by the Secretary of State in 1921; but the depressed condition of Imperial finances has made its immediate realization impossible. The Government of India have, therefore, decided to utilize in the meantime the facilities already available at the Institute, and to start from the 1st of November, 1923, post-graduate courses in agricultural chemistry, botany, mycology, bacteriology and entomology to qualify for Imperial appointments in the Agricultural Service. The period of each course will be two years. As a start it is proposed to admit 12 students, *viz.*, 3 in agricultural chemistry, 2 in mycology, 2 in entomology, 3 in agricultural bacteriology and 2 in botany.

As regards the training of Deputy Directors of Agriculture and Professors of Agriculture, the Government of India have decided to begin with a course in animal husbandry and dairying. This will be given at the Imperial Dairy Institute, Bangalore, and at Pusa. The course will last for 15 months and will be confined for the present to officers of the Provincial Service who have put in at least two years service.

Six **agricultural schools** with 138 students are at work in BOMBAY. The Sind school having proved unsuitable to the conditions of the province has been closed, and, in response to a strong local demand, two new schools have been opened at Dhulia and Surat. At Dhulia, a local committee has been formed which has

undertaken to provide school accommodation and to bear the whole cost of maintenance of the boys, the Government furnishing the staff and farm, while the Surat school has started with an annual subsidy of Rs. 2,500 from the district board. All the four old schools are now flourishing, and during the present year the training of teachers for a new type of rural primary school, with an agricultural bias, has been added to their duties. There are fifteen teachers in training at these schools.

There are two agricultural middle schools with a course of instruction extending over two years in MADRAS, the one at Taliparamba with 18 students and the other at Anakapalle with seven pupils on the rolls. Both schools have worked for only a year, and it is too early to say whether a demand will arise for the type of education imparted by them.

The two secondary agricultural schools at Dacca and Chinsura in BENGAL had under instruction last year 36 and 33 students respectively. In the present session, however, the number has diminished, partly because of the insistence on the recruitment of students directly connected with the land, and chiefly because, on account of retrenchment, no Government posts could be offered to the 25 students who passed out. Considering that practically all the students receive a stipend of Rs. 10 per month, it does not appear that there is a demand for such schools beyond those necessary to provide subordinate officers for the department. The agricultural classes attached to the Amarpur and Durgapur schools are, however, reported to be doing well, and it is proposed to start similar classes at three more schools.

The agricultural school at Pathra (Godda) in BIHAR AND ORISSA, the missionary management of which receives a monthly subsidy, had 75 students under training during the year under report.

The Bulandshahr agricultural school in the UNITED PROVINCES, which gives a vernacular course of two years, provides a system of education which will fit the tenant or small zemindar to his station in life, and offers him an alternative to the literary education which is alone at the present time available to those youths of this class who desire to advance. The instruction at

this school is strictly vocational: the students are made to cultivate the land on a system of *batai*, produce is handled on co-operative basis, while detailed accounts are kept of all transactions of this nature. As the school was opened in 1921 no students have completed the course and it is too early to speak confidently of the success of the experiment, but the number of applications for admission indicate that there is a demand for this type of education.

The agricultural schools at Chandkhuri and Powarkhera in the CENTRAL PROVINCES are still run with a less number of students than could be accommodated, and even those who join leave without completing the course. It is believed that the revised curriculum adopted at the Powarkhera school, whereby agriculture is combined with a course on the lines of the ordinary middle school, will assist in solving the problem of vocational training.

Another experiment in agricultural education has been tried, with little success however, by opening a vocational six months' agricultural class at Akola for instruction in practical agriculture. In addition to the monthly stipend of Rs. 10, the students were paid for work on the farm at the rate of 6 annas per day of four hours' work, but the first batch left the school on learning that no service was guaranteed on the completion of training. Others, however, came and eventually 11 remained to complete the course. It is not proposed to repeat the experiment.

There are no special agricultural schools in the PUNJAB, but ordinary vernacular middle schools are utilized for imparting a practical training in agriculture to school boys in rural areas. The special features of the scheme are that (*a*) a farm is attached to the school with an area and equipment sufficient for practical training on a reasonably large scale, and that (*b*) the training is given not by one of the ordinary school teachers but a teacher specially selected for the work and trained for a year at the Agricultural College at Lyallpur. The scheme has achieved an immediate popularity, and over a quarter of the total number of vernacular middle schools in the province now impart training in agriculture.

Twenty-nine students are under training at the Pyinmana agricultural school in BURMA which started working on the 6th June, 1923, under the management of the American Baptist Mission.

The diploma examination was held for the first time since the course at the Hebbal school in MYSORE was extended to three years. All the 13 students in the final class were declared successful. The 12 students at the other school at Chikkanhalli qualified for a certificate at the end of the year.

The newly opened agricultural school at Alwaye in TRAVANCORE, which has accommodation for 32 students, is reported to have had a successful year.

***Short courses.*** The six months' practical vernacular course at LYALLPUR was taken advantage of by 24 students, while 12 senior vernacular teachers took the course to qualify themselves for the teaching of agriculture in rural middle schools of the Punjab. The rural economy class, which lasts for a month, was attended by 20 officers of other departments who have proved of great assistance in introducing agricultural improvements in their jurisdiction.

The one-year short course at the POONA College, for farmers' sons with a knowledge of English, has been restarted, and judging by the class of men applying for admission, it promises to be useful.

Forty elementary school teachers from Vizagapatam and Godavari Districts of the MADRAS Presidency deputed for training in practical agriculture were given a month's course at Anakapalle and Samalkota. The classes for juvenile and adult labourers on the farms at Coimbatore, Palur and Anakapalle continued to function.

In addition to the usual training of overseers on the central farms in BIHAR, five men were given short courses in practical agriculture at Cuttack and Kanke.

Short practical courses in the driving of tractors, the handling of tractor implements and oil-engine management are given on the Nagpur farm in the CENTRAL PROVINCES.

The class opened on the Mandalay farm for training of junior agricultural assistants required by the BURMA department having failed to attract the right type of men has been closed.

In ASSAM 15 apprentices were under training on different farms of the province for employment as demonstrators.

## CHAPTER VII.

## THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

The year under review has been marked by a steady expansion of agricultural credit societies. Not only has the number of agricultural credit societies risen, but there has been also a remarkable growth of deposits by members in their primary societies and a satisfactory increase in the working capital and reserve fund. The growth of non-credit agricultural societies continues, however, to be slow, but a more rapid advance is certain to come when the full advantage of co-operative action in many directions is realized. It is, however, gratifying to note that there is now a closer association between the Agricultural and Co-operative Departments.

The following facts and figures taken from provincial co-operative reports give some idea of the progress of the movement during the year.

**Bombay.** The improvement and consolidation of existing societies rather than their extension being the policy pursued during the year, the rise in the number of agricultural societies has been very small, *viz.*, from 2,753 to 2,869; in other words, the increase is only a little more than 100 as compared with 400 in each of the last two years. The membership declined from 208,085 to 207,372, but the working capital, on the other hand, rose from Rs. 160 lakhs to Rs. 176 lakhs. During the last three years the number of agricultural co-operators has increased by 33 per cent. and their working capital by 60 per cent. There are still almost 9 out of every 10 cultivators in the province outside of the co-operative movement. Over-dues have unfortunately grown from Rs. 19½ lakhs to nearly Rs. 31 lakhs or over 18 per cent. of the working capital; but it is reported that this is due mainly to the adverse agricultural season.

The number of non-credit agricultural societies rose from 146 to 159. Co-operative marketing appears to be the type of

agricultural non-credit work which is likely to have most success in this presidency. The cotton sale societies continue to be the best developed type. The total sales through co-operative marketing amounted to Rs. 33½ lakhs, of which Rs. 23·8 lakhs were contributed by cotton and Rs. 7·8 lakhs by molasses. An important beginning towards land improvement through the co-operative movement was made by the registration of four societies for fencing against the ravages of wild pigs. Three of these societies made good progress during the year and erected fences totalling over 9,000 yards. The societies for sale of manures did useful work during the year. The most important items of manure sales have been through the shops connected with branches of the Provincial Bank at Baramati and Kopergaon which sold manure worth Rs. 5 lakhs as against Rs. 3 lakhs in the previous year. The implements societies are still on a small scale and their utility is doubtful. Cattle-breeding and seed societies have both proved disappointing.

The Co-operative Institute is now taking a distinctly larger and more influential part in the direction of the co-operative movement in the province. The number of members rose from 2,799 to 3,177. The Institute conducted 41 night schools and held training classes for secretaries, honorary organizers and bank managers which were all well attended.

**Madras.** There has been considerable expansion of agricultural credit societies during the year, especially amongst the depressed classes. The number rose from 6,206 to 7,100, membership from 326,612 to 376,679, the working capital from Rs. 2,22,92,429 to Rs. 2,65,39,957 and the reserve fund from Rs. 10,88,407 to Rs. 13,07,238. Loans for nearly Rs. 126·98 lakhs were granted, of which Rs. 85·66 lakhs were for productive purposes, Rs. 37·76 lakhs for reducing prior debts and Rs. 3·5 lakhs for non-productive purposes.

Of the 95 non-credit agricultural societies at work during the year, 77, with a working capital of Rs. 4,01,986, were concerned with the purchase and sale of agricultural requisites and products to members. Thirty-two of the latter worked at a divisible profit of Rs. 12,793 and 45 incurred a loss of

Rs. 17,609. Nine new societies for tenants, which have as their object the obtaining of land for cultivation by members, were registered during the year.

**Bengal.** The number of agricultural credit societies rose from 6,047 to 7,011, membership from 170,067 to 186,944, working capital from Rs. 1,30,80,811 to Rs. 1,48,62,021, and the reserve fund from Rs. 18·32 lakhs to Rs. 21·63 lakhs. The over-dues, however, are still large.

There has been also a satisfactory growth of agricultural non-credit societies of all classes, the total number increasing from 99 to 202. It is satisfactory to note that the societies for purchase and purchase and sale, which now number 21, worked at a profit of Rs. 5,910 during the year against a loss of Rs. 326 in the preceding year. A scheme for the distribution of jute seed through co-operative organization has been formulated in consultation with the Director of Agriculture of the province, and it should prove a great advantage to the jute growing members. The most remarkable progress has been with irrigation societies which have increased from 29 to 114 during the year. Of these, 66 are in Bankura, 45 in Birbhum, one in Burdwan, one in Midnapore and one in Faridpur District. Of the schemes completed, the Amjhore Khal and the Rukmini Khal projects deserve mention. In the first scheme which will irrigate an area of 700 acres, a masonry weir has been constructed across the Amjhore Khal and irrigation channels extending to 4 miles in length have been excavated. The other scheme is for the construction of a masonry weir across the Rukmini Khal and the excavation of long and deep irrigation channels. The irrigation channels have been excavated and it is now possible to lead water to the fields of members within a distance of about a mile and a half. The immense benefit of these projects was effectively demonstrated this year when, owing to a deficiency in the local rainfall in Bankura, water was distributed from the Amjhore Khal and the Rukmini Khal to the withering crops in the fields within the area, which was transformed into a vast expanse of luxuriant growth, presenting a striking contrast to the dying paddy in the surrounding fields.

The Naogaon Ganja Cultivators' Co-operative Society advanced this year Rs. 2,63,605, free of interest, to its members to mitigate their distress due to the effects of the floods in Northern Bengal. The society continued to spend considerable sums on numerous schemes of public utility in the locality.

**Punjab.** The number of agricultural societies of different types increased from 8,757 to 8,853, but membership showed a slight decline from 238,668 to 223,043. The working capital, on the other hand, rose from Rs. 252 lakhs to Rs. 263 lakhs and the reserve fund from Rs. 57 lakhs to Rs. 61 lakhs. Over 90 per cent. of the credit societies which have been working for ten years are now financially independent.

The Jhang Mortgage Bank continued to afford valuable relief to members whose land is encumbered for relatively small sums. During the year under review, it advanced about a lakh of rupees, over one-third of which brought about redemption of 663 acres of land and 950 palm trees.

The two co-operative seed and demonstration farm societies at Montgomery and Lyallpur had a successful year. Over 640 implements and a considerable amount of selected seed was distributed through these and other societies. An Improved Farming Society, all the members of which agree to use improved implements and pure seed, is being organized in Gujrat, and an intensive campaign now being carried on in a few selected villages in Sialkot is likely to result in the establishment of more such societies. A scheme of some interest is being tried on the infertile (*bara*) land on the Lower Bari Doab Canal where a number of squares were allotted to members of societies from tracts which needed relief. In all, there are now five land-holding societies with 112 members.

At the end of the year there were 133 societies for the consolidation of holdings with 5,255 members as against 107 with a membership of 3,397 in the preceding year. Generally speaking, the propaganda work has been confined to the Central Punjab and the chief progress has been made in Gurdaspur, Hoshiarpur and Jullundur Districts. In Jullundur District especially, where the greatest success has so far been claimed,

the average size of the field has increased from less than half to nearly three acres, and as a result of repartition 1,750 acres of waste have been brought under cultivation. The area consolidated during the year consisted of over 12,000 acres in 12,820 scattered fields which were consolidated into 2,459 compact blocks. Similar work is proceeding vigorously in many other places. The cost of this great and beneficial change works out at about R. 1-8-0 per acre adjusted. A real revolution of incalculable benefit to the cultivators of the central districts of the Punjab has been definitely started, and the movement is already attracting attention outside the province.

The silt clearance societies, of which there are now 18 with 302 members, are doing useful work in inundation canal systems.

Another useful type of society in the Punjab is the breeding society, of which there are 20 for cattle-breeding and seven for sheep-breeding. An experiment in the formation of fodder storage societies is in progress in Hissar and Jhelum.

There are five co-operative commission sale shops at work; these have 647 individuals and 145 societies as members, and their dealings in members' products rose from under Rs. 4 lakhs last year to over Rs. 9·8 lakhs. It is estimated that the savings through these transactions amounted roughly to Rs. 43,000.

**United Provinces.** The number of agricultural societies rose from 4,857 to 5,208, membership from 116,845 to 124,840, working capital from Rs. 64,70,669 to Rs. 73,94,503 and the reserve fund from Rs. 11,12,769 to Rs. 12,30,611.

The number of non-credit societies remained stationary. Attempts are now being made to organize societies for joint sale of agricultural produce.

**Central Provinces and Berar.** There was a further decline in the number of societies of all kinds. The number of agricultural credit societies fell from 4,496 to 4,416 and membership from 73,112 to 70,820. The working capital, however, rose from Rs. 1,22,33,249 to Rs. 1,27,62,195 and the reserve fund from Rs. 12,92,504 to Rs. 16,39,916.

The number of non-credit agricultural societies declined from 32 to 28. The agricultural unions were mainly engaged

in the propagation and distribution of pure seed of roseum cotton, of which 1,520 tons were distributed during the year, showing an increase of 267 tons over the figure of the preceding year. Some of these unions also do useful work in maintaining stud-bulls and in the introduction of improved agricultural implements by stocking improved ploughs for sale and hire. The main activity of the agricultural associations continued to be the hire and sale of improved ploughs. Their paid-up share capital increased from Rs. 10,626 to Rs. 14,852, while their total sales rose from Rs. 10,649 to Rs. 14,384.

**Burma.** The number of agricultural credit societies rose from 4,023 to 4,039 and membership from 93,518 to 94,954; whilst the working capital declined from Rs. 1,69,75,843 to Rs. 1,63,10,190 and the reserve fund from Rs. 26,50,930 to Rs. 25,65,291. Many of these credit societies proved to be of considerable value in distributing improved selected seeds from the Agricultural Department.

The purchase and sale societies, of which there are nine, have not yet achieved importance and there has been no considerable increase in distribution business. The two societies for production have both failed. The number of production and sale societies, however, has increased from 67 to 74. These showed losses on the year's working in every district, except in Pakokku. The co-partnership tenancy and credit societies settled on the disafforested reserves near the mouth of the Sittang river now hold nearly $1\frac{1}{4}$ lakhs of acres of land, and are reported to be in a prosperous condition.

**Bihar and Orissa.** The number of agricultural societies rose from 3,861 to 4,661, membership from 112,421 to 134,821, and working capital from Rs. 64,04,598 to Rs. 85,59,059.

Sustained progress was maintained during the year in the matter of agricultural improvements. Large quantities of improved seeds of different varieties were distributed, and the central banks also gave out loans amounting to Rs. 19,000 from their own funds, which may be broadly divided into two parts, *viz.*, Rs. 11,000 for the construction of wells, embankments and for storage of water, and Rs. 8,000 for reclamation of waste lands. The agricultural sale societies which now number

31 are not in a satisfactory condition. The number of grain *golas* (stores) rose from 72 to 85 and these made good progress. The *golas* afford relief to the members in the shape of loans at very low rates of interest and serve as a reserve stock for use during years of scarcity.

**Assam.** The number of agricultural societies rose from 555 to 583, membership from 24,579 to 25,435 and working capital from Rs. 7,07,211 to 8,00,750. The capital available per member is, however, still inadequate. There are no societies for agricultural production or for the sale of produce.

### Co-operative Cotton Sale Societies.

The methods and the working of co-operative marketing societies in the province of Bombay were thoroughly investigated during the year by the Registrar and the Director of Agriculture. As a result of the investigations much greater development is expected in this direction. The Gadag sale society still leads in marketing and sold cotton worth 9½ lakhs of rupees. The Hubli society has again done very well and is leading the way for clean picking of cotton. During the last season the Gadag society handled 11 per cent. of the cotton brought into the market; the Haveri society 18 per cent.; the Dharwar and the Hubli societies each 7 per cent. In Gujarat the success of the Sonsek society in disposing of cotton lint has led to the registration of six new sale societies in the Broach District. The cotton sale society has not been a success so far in East Khandesh, and the causes operating against it are being investigated by the Agricultural Department.

### Co-operative Milk Societies.

The Saidapet Milk Supply Society in MADRAS supplied milk to its members to the extent of Rs. 722.

In BOMBAY the number of dairy societies was reduced to 7. The societies at Belgaum, Malvan, Bagalkot and Dhulia in all sold milk to the value of Rs. 40,800 and earned a profit of Rs. 2,804.

In the CENTRAL PROVINCES, the Amraoti Co-operative Dairy sustained a loss of Rs. 422 during the year. The two Nagpur *gaoli* societies were amalgamated, and the members sold last year 365,350 lb. of milk and earned a profit of nearly Rs. 10,567.

The Katra Co-operative Dairy in the UNITED PROVINCES continued to do useful work and made a profit of Rs. 539 this year.

Thanks to good management, the milk societies in the Baraset area of BENGAL, which are now 52, continue to progress satisfactorily. They supplied 2,870 lb. of milk daily to Calcutta, as against 2,622 lb. in the previous year.

## Cattle Insurance.

In the PUNJAB, the number of societies declined from 41 to 39 and membership from 529 to 365. Financially, however, these societies appear to be sound enough. Rs. 2,318 was collected as premia, and Rs. 247 was paid out for five animals lost.

The one society at Jaraoli in the UNITED PROVINCES did more business than in the previous year.

The number of societies in BURMA rose from 383 to 397 and membership from 6,013 to 6,102. The premia collected, however, declined from Rs. 3,957 to Rs. 3,605 and the number of animals insured from 3,056 to 2,305. Model by-laws for the improvement of cattle insurance societies were revised and issued this year.

## CHAPTER VIII.

## LIVE STOCK.

### I. Prevention and Treatment of Disease.

The year's work by the Civil Veterinary Department is detailed in tabular form on page 133 (Appendix VII). Twenty-six new hospitals and dispensaries were opened during the year, bringing the total to 642. The cases treated and castrations performed in these institutions rose from 1,242,751 in the preceding year to 1,398,877 in the year under review, while those dealt with by the itinerant staff increased from 768,984 to 858,950. These figures clearly indicate the steady advance of the department in the esteem of the cattle owners of the country. As a matter of fact, owing to the inadequacy of the staff, the department is unable to meet all the calls made on it for medical aid, and it rests with district boards and other similar organizations to make provision for the growing demand.

On the whole, live stock suffered less from contagious diseases than in the previous year. The mortality reported was 211,930 as against 237,332 in 1921-22. There was a slight fall in the number of outbreaks and a sympathetic reduction from 715,691 to 679,195 in the number of preventive inoculations carried out.

In Madras a system was introduced by which through the levy of a small fee of annas eight for each animal inoculated against rinderpest by the " serum alone " method, Government undertook to re-inoculate the same animal as many times as is necessary during the following six months. The system has not, however, been in force sufficiently long to judge of its effect on the number of inoculations.

The reporting of contagious diseases has been noticeably better in some of the districts but there is still room for improvement. The introduction of the post card system proved generally satisfactory in the Central Provinces, while in the

Punjab to stimulate promptness in reporting the Government allotted Rs. 6,000 for rewards to Patwaries. Sanads were also awarded to Malguzars and others who rendered assistance to the veterinary staff in carrying out inoculations and castrations.

## II. Incidence of Disease.

*Bombay.* Rinderpest and hæmorrhagic septicæmia were not so widely prevalent as in the previous year and occurred sporadically, but there was a considerable increase in mortality from black-quarter, 3,167 deaths being reported against 222 last year. On the whole the year was healthy for live stock generally.

*Madras.* The mortality from contagious diseases has again fallen, the figures for the year being 28,178 as against 34,258 in the previous one. It is especially gratifying that the mortality from rinderpest, *viz.*, 4,279, was lower than it has been for many years past.

*Bengal.* Despite the dryness of the season, contagious cattle diseases were responsible for nearly 24,000 deaths as against 16,142 in the previous year. About 80 per cent. of these were due to rinderpest and 10 per cent. to hæmorrhagic septicæmia.

*Bihar and Orissa.* Contagious diseases, especially rinderpest, hæmorrhagic septicæmia and foot-and-mouth disease, were more virulent in certain districts and accounted for 30,737 deaths in the province as against 28,655 in the year 1921-22.

*United Provinces.* The mortality from contagious diseases rose to 14,254 from 11,029 in the preceding year. The increase is mainly due to severe outbreaks of rinderpest, hæmorrhagic septicæmia, black-quarter and anthrax and to the extension of the prevalence of surra. The death rolls for rinderpest and hæmorrhagic septicæmia were 7,266 and 3,266 as against 5,976 and 1,791, respectively, in the past year. Surra accounted for 54 deaths but it is believed that many more cases occurred about which no reports were recorded.

*Punjab.* The year was unusually healthy for live stock until the latter half when hæmorrhagic septicæmia appeared in the low-lying areas along the banks of the rivers. Among the bovines the mortality from this disease amounted to 13,684

against 10,923 in the previous year. There was a marked decrease in the number of reported deaths from rinderpest, the number being 6,936 against 23,661 in the previous year.

*Central Provinces.* Deaths from contagious diseases were about half as numerous as in the previous year and only about one-fourth of the average of the preceding four years. Mortality from rinderpest was specially light, the deaths being returned at 1,725 against 10,025 and 41,725 in the two preceding years respectively. For the first time a case of dourine was confirmed in Berar.

*Assam.* The total mortality reported from contagious diseases was 25,309 against 30,594 in the previous year. The heaviest mortality reported was from Sibsagar. There were 110 deaths from surra as against 80 in the past year.

*Burma.* The total number of deaths from contagious diseases was practically the same as that in the preceding year, rinderpest, however, showing a reduction of about 2,000. In the Shan States, the total number of deaths from all causes was 203, of which 35 were due to surra.

*North-West Frontier Province.* The total number of deaths from contagious diseases dropped from 3,106 in the preceding year to 476 in the year under review and were mostly due to rinderpest and hæmorrhagic septicæmia. Six cases of surra were reported against 10 last year, while no case of dourine was detected.

*Sind.* During the year, the number of outbreaks of contagious diseases was remarkably small, with a corresponding reduction in the number of deaths. As usual, the casualties were mostly due to rinderpest which carried off 4,401 cattle as against 12,062 in the previous year.

*Baluchistan.* Only one outbreak of rinderpest was reported from the Quetta-Pishin district which resulted in 13 deaths as against 126 of the past year. The total number of deaths from all causes was 1,125 against 545 in 1921-22.

*Rajputana.* There was a further decrease in the reported mortality which fell from 124 to 99, of which 71 were due to anthrax.

## III. Veterinary Education.

For the training of students in veterinary science, there are colleges at Bombay, Madras, Calcutta and Lahore and schools at Insein and Taunggyi in Burma.

The colleges at Bombay, Madras and Calcutta continued to give a 3-year diploma course in English, while that at Lahore gave a 4-year course in English in addition to the remaining part of the old 3-year course in vernacular which it has replaced. The total number of students who passed the final examinations of the colleges during the year under review was 112 as against 149 of the preceding year. With a view to induce better qualified youths to undergo the course at the Bombay college, the scale of Government scholarships was raised from Rs. 20 to Rs. 30 per mensem, by reduction of the number from 21 to 14. The number of stipends at the Madras college was reduced from 40 to 15 per annum on financial grounds.

A scheme for the opening of a veterinary college at Patna has been under consideration, but no definite decision has yet been arrived at.

The veterinary schools at Insein and Taunggyi continued to impart instruction in the vernacular in a 3 years and a 1½ years course respectively. Ten students passed the final examination at Insein. The future organization of this school was considered by a committee which proposed to make the course of training at the school more complete and to equip it adequately for surgical and laboratory work. If the recommendations of the committee are accepted by the Local Government, the requirements of the province will be met for some years to come.

The trial course of post-graduate training of officers of the provincial grade selected for promotion to the Imperial branch of the service was continued at the Imperial Bacteriological Laboratory, Muktesar, and showed fair prospects of success.

The second meeting of the Veterinary Conference was held at Calcutta in February-March 1923, and many questions of vital importance, such as, veterinary education, epizootic diseases and legislation, were fully discussed at it. The proceedings of the conference will be published shortly.

The United Provinces Veterinary Medical Society continued to do good work. An Urdu monthly veterinary journal is published by the Society. Much useful work was done by means of magic lantern demonstrations and lectures on subjects connected with live stock generally.

## IV. Breeding.

***Cattle-breeding.*** There is perhaps nothing of such importance to the prosperity of Indian agriculture as the welfare of the cattle, but it must be admitted that during the last twenty years while there has been considerable progress in cropping, it has become increasingly difficult in most parts of India to procure in the open market, no matter what price is paid, good quality draught or milk cattle in any numbers. Such a situation has probably been brought about by the inexorable working of economic laws, where the cattle have been reduced to compete with their masters for their food supply. The cattle over a large part of India have now to subsist on fodder composed of the stalks of over-ripe grain crops by itself of insufficient nutritive value. The average grazing land attached to a village is, moreover, hopelessly inadequate to supplement the poor quality of fodder. So far as can be seen at present, irrigation presents the only real solution to the fodder difficulty, offering as it does ample opportunities of growing catch crops in the arable areas.

So far as breeding is concerned, the immediate problem, now that the large grazing areas have been so much curtailed by colonization, is to produce the necessary cattle in the arable tracts. It is obvious that for most parts of India the dual purpose (*i.e.*, milk and draught) will be by far the most economic type. The improvement of the cattle in both these directions has now been placed in the forefront in the programme of most Agricultural Departments, and five provinces have already a special section devoted to cattle-breeding and dairying.

The scarcity of milk in urban areas and the fabulous price demanded for the pure article have directed public interest to the cattle problem, but the usual remedies suggested indicate a wrong perception of the situation. With a view, therefore,

to educate public opinion on right lines and to stimulate an interest in cattle-breeding and dairying, lectures illustrated by cinema films have been given at different centres.

At PUSA, as explained in previous reviews, cattle-breeding operations have been directed along two lines :—

(1) The grading up of a country milk breed.

(2) Experiments in cross-breeding with imported bulls of high milking pedigree with the primary object of obtaining reliable information regarding the inheritance of observable characters of both breeds.

The Punjab Montgomery or Sahiwal cattle are being used as a representative milk breed for grading experiments and also as the female parent for cross-breeding with the Ayrshire which has, by previous experience, been found to be a suitable male parent. The immediate result of the cross-breeding was to produce an animal giving twice the quantity of milk of the best Montgomeries, although the mothers were the worst milkers in the herd. The maintenance of the high milk yielding qualities in subsequent generations will, however, most probably prove a matter of some difficulty owing to the large number of rejections necessary to establish a new breed. Be this as it may, the success of the first cross has clearly demonstrated a sure and rapid method of creating high milk yielding cows for dairying purposes the lack of which has, undoubtedly, led to the serious position of the milk supply of the large cities in India. How long will it be before public enterprise *avails* itself of the opportunity now presented to it? There now no longer exists any excuse. The price of milk has steadily increased during the past few years, the means of obtaining high yields of milk and reasonably cheap green fodder have been amply demonstrated, and the Government of India have recently transferred three of the military dairy farms to the Agricultural Department for the purpose, amongst other things, of offering a thorough training in modern dairying to dairy managers. Hitherto there has been " much cry but precious little wool " from the public on the question of the milk supply in spite of all that has been done by Government to assist them.

It is to be hoped that municipalities and other bodies concerned will now make an effort to show the way. The facilities in the way of technical advice and training are ample and may not exist later on unless fully availed of now.

In the PUNJAB, the cattle-breeding operations remain in charge of the Veterinary Department whose policy is the preservation and improvement of the indigenous breeds by mass selection. The application of this process on the Hissar farm has resulted in the establishment of the Hissar breed of draught cattle. Through subsidizing private breeding operations in villages, the grading up of the famous Hariana, Dhanni and Montgomery breeds has been taken in hand.

With the continuance of good harvests in the North-West Punjab the scheme for breeding Dhanni bulls started in 1918 has now established itself: 69 bulls were on the rolls in the three districts of Attock, Jhelum and Rawalpindi at the end of the year as compared with 46 in 1921-22. A noticeable improvement in the last 5 years in the number of well-bred cattle available in the Dhanni tracts is reported, and steps are now being taken to start a herd book for maintaining the purity of the breed. The success of the scheme has led to a demand for its extension to outside areas where a nucleus of this breed is in existence.

A similar scheme for the Hariana tract has been well received by the district boards of Rohtak and Gurgaon, and a number of specially selected young male stock have been received on the Hissar farm for rearing until fit for issue. Meanwhile 116 stud bulls have been distributed in the Gurgaon District alone, part of the cost being advanced in each case by applicants.

The majority of the eight cattle-breeding farms (3 for the Hissar breed, 3 for the Montgomery breed and 2 dairy farms) given on lease by Government have reached their full strength, and it was found possible during the year to issue specially selected male stock for breeding purposes.

Two hundred and nineteen bulls were issued from the Hissar farm to the districts as against 215 in the preceding year. The total number of bulls in the province at stud rose to 1,637, there being 339 additions and 239 casualties.

In the NORTH-WEST FRONTIER PROVINCE, 56 bulls belonging to the local bodies were at stud during the year.

In the UNITED PROVINCES, a beginning has been made in the raising of pedigree herds of cattle selected to meet both the need for working cattle and milking stock at the Government farms at Madhurikund and Manjha. The former deals with the larger western breeds, such as the Hissar, the Kosi, the Montgomery and English-Montgomery cross-breds, while the latter specializes in the well-known local Kherigarh breed. Forty bulls were issued during the year from these farms, but a much larger number will be available with further development.

Results obtained at the Rangpur cattle farm, which was started to ascertain whether it would be possible to raise improved cattle in BENGAL instead of depending on importation from up-country as is the present practice, are distinctly promising. Both *desi* and imported Hansi bulls are used for mating with indigenous cows. The use of the latter, as might be expected, at once raises the size of the progeny. There has also been a considerable improvement in the milk yield of the cows. While in 1920 when the full stocking of the farm permitted the first weeding out process, it was found necessary to lay down a standard as low as 500 lb. of milk per lactation period for retaining cows in the herd, this year, when the whole position was reviewed, it was found practicable to raise this to 1,500 lb.

Breeding herds are maintained at Ranchi, Sipaya and Sabour in BIHAR. The first object in view is to raise locally Montgomery herds of milk pedigree, the next step being the crossing of these with local cows in order to obtain finally a type of animal which will give a better yield of milk and comply with local requirements in other respects. Fifty-four animals, including calves, were distributed during the year under report in the countryside from these farms. A similar herd is being established at Cuttack, and it is also intended to start a new farm at Monghyr, purely for breeding cattle.

The policy of breeding two distinct herds, one of pure Patna and the other of Patna-Bhutia cross-bred cattle, was continued at the Upper Shillong farm in ASSAM.

The stock-breeding work in BURMA having been transferred to the Agricultural Department, a small nucleus herd of Sindhi cattle has been established for the proposed dairy farm.

There are nine cattle-breeding farms and one dairy farm in the CENTRAL PROVINCES. Hitherto these farms were intended to form centres of supply from which pure bred bulls could be obtained, each herd being representative of the breed most favoured in the tract in which the farm was situated. On account of the difficulty experienced in getting suitable stud bulls for these herds, the whole cattle-breeding policy has been changed, and it has been decided to use Sahiwal (Montgomery) bulls in all herds, except at Hoshangabad and Raigarh where pure bred Malvi and Gaolao herds will be maintained. It is thus hoped to grade up all Government herds which will provide a supply of bulls carrying the milk character. A premium system was introduced during the year, under which the purchaser of a bull approved by the department obtains an annual premium varying from Rs. 40 to Rs. 80 for the maintenance of a stud bull. In the year under report, 91 applications for the premium were received but only 20 were granted owing to the scarcity of suitable bulls offered. If a rigid selection and rejection of unsuitable animals is adhered to, the premium system should do much to encourage the keeping of the best animals as bulls instead of their being castrated, as is only too common in many parts of India. Three hundred and sixteen cattle were sold from Government farms during the year, of which 59 were bulls.

Amongst the cattle-breeding activities of the department in BOMBAY, pedigree herds have been established (1) at Charodi for Kankrej cattle and (with special reference to milking qualities) at Surat, (2) of Amrit Mahal cattle at Bankapur in the Dharwar District, (3) of Sindhi cattle at Malir near Karachi and at the Agricultural College Dairy in Poona. These form the nucleus herds for the study and improvement of the breeds involved and in all cases the standard of the animals is well above that of the local breeders. The demand for breeding bulls from these farms is strong and is specially insistent from the south of the presidency. The report of the committee appointed to consider the question of cattle improvement and fodder storage in all its

aspects has been received and is now under the consideration of the Government.

In MADRAS, the main lines of work aim at the production of a number of good type Ongole, Kangayam and cross-bred bulls. The cross-breeding work hitherto carried on at the Bangalore military dairy farm has now been transferred to Coimbatore which will be in future the headquarters of the Deputy Director of Live Stock.

Three Holstein bulls have been obtained for the Rayankere dairy farm in MYSORE to cross with Amrit Mahal and Sindhi cows, while on the Hebbal farm the possibility of improving the milk yield of the local cows by selection is being explored.

Two cattle-breeding stations are maintained in the TRAVANCORE STATE, from which a few calves of the Sindhi breed were sold to the public during the year.

In BARODA the dairy farm started with the object of building up a pedigree herd of Gir cattle has had a successful year.

***Sheep-breeding.*** Experiments are in progress in the Upper India provinces to grade up the indigenous sheep by cross-breeding with Merino and other superior wool breeds. Results hitherto achieved are by no means discouraging so far as wool is concerned, and it is hoped that the graded up progeny will also to a certain extent combine weight of wool with carcase production.

The introduction of the Merino strain on the Government sheep runs in the UNITED PROVINCES, which has unfortunately been closed down owing to want of funds, has demonstrated that it is possible, by a judicious introduction of good wool-bearing blood crossed with herds of selected indigenous ewes, to grow a very improved quality of wool and to increase considerably the annual production.

Steady progress is being maintained in popularizing the use of Merino rams for breeding purposes in the PUNJAB. During the year 47 rams and 121 ewes bred on the Hissar farm were purchased by private individuals. The department is assisting breeders in securing favourable rates for cross-bred Merino wool by arranging direct sale with the mills. This, however, could be done far more readily through co-operative sheep-breeding

societies and every effort is being made to encourage the establishment of these agencies.

In MYSORE, the three-quarter bred Merino is found to be an improvement on the half-bred so far as wool is concerned. A sheep-breeders' association with 70 members all actively engaged in the industry has been started in the Kolar District with Government subvention: this would lead to organized and co-operative effort for the improvement of the sheep-breeding industry.

## CHAPTER IX.

## PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

A complete list of agricultural publications issued in India during the year under review is given in Appendix X. Briefly summarized, those issued by the Imperial and Provincial Departments of Agriculture are as follows :—

***Imperial.*** Nineteen memoirs, 14 bulletins, and seven other publications were issued during the year by the Pusa Research Institute, while over 15 publications were in the press on the 30th June, 1923.

Bulletin No. 28 on Lac Cultivation in the Plains of India, of which two editions had already been exhausted, was brought up-to-date and issued as Bulletin No. 142 which is practically a new publication. To meet the constant demand for another bulletin of practical importance (No. 46 on Bee-keeping), a second edition was sent to the press.

" The Agricultural Journal of India," which is issued every two months, continued to maintain its popularity among the class of readers for which it is intended.

***Provincial.*** The quarterly Journal of the BENGAL department, which is issued both in English and Bengali, had a third successful year of existence.

In BOMBAY, in addition to the regular issue of " The Poona Agricultural College Magazine " and the vernacular journals of the agricultural associations, three bulletins and nine leaflets along with their vernacular versions were published.

With a view to give the public some estimate of the value of its activities " A Popular Account of the Work of the MADRAS Agricultural Department " was published and distributed free amongst influential landlords. A monthly digest of the operations of the department was also very widely circulated through the revenue and co-operative agencies and 15 important newspapers. About a hundred thousand copies were printed of the

Villagers' Calendar for 1922-23 in English and in all the vernaculars of the presidency, and the number of leaflets issued was eight.

The publication of a departmental journal in the UNITED PROVINCES has been held up on account of financial considerations, but a scheme for the reorganization of the two vernacular periodicals, (1) "Mufid-ul-Mazarain" in Urdu and (2) "Kishan-Upkarak" in Hindi, has been approved.

The publication of short monthly notes on "What to see at the farms" in both English and vernacular newspapers is being continued by the BURMA department. A bulletin on *Striga lutea* was issued, some of the old leaflets and bulletins were revised or rewritten as required, and the agricultural calendar and a large poster describing the life and habits of the Rhinoceros-beetle were widely distributed.

In ASSAM, a leaflet on selection of rice for seed and a bulletin entitled "How to can fruits and vegetables at home" were brought out.

## CHAPTER X.

## EXPENDITURE OF THE AGRICULTURAL DEPARTMENTS.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year ending the 31st March, 1923, was Rs. 9,28,841 as against Rs. 9,65,956 during the previous year. The details are given below :—

| | Rs. |
|---|---|
| General expenditure of the Institute (including the office of the Agricultural Adviser and Director) . . . . | 2,81,095 |
| Botanical Section . . . . . | 65,265 |
| Chemical Section . . . . . | 61,514 |
| Physiological Chemical Section . . | 38,277 |
| Bacteriological Section . . . . | 67,385 |
| Mycological Section . . . . | 62,732 |
| Entomological Section . . . . | 52,156 |
| Pathological Entomological Section . | 21,213 |
| Agricultural Section . . . . | 1,29,635 |
| Indigo Research Section (closed from 20th May, 1922) . . . . . | 6,784 |
| Imperial Dairy Expert . . . . | 39,592 |
| Sugar Bureau . . . . . | 25,368 |
| Indian Central Cotton Committee . . | 77,825 |
| TOTAL . | 9,28,841 |

The expenditure on the working of the Imperial Bacteriological Laboratory at Muktesar during the period amounted to Rs. 7,55,815 as against Rs. 7,06,331 in the previous year.

The total expenditure incurred by the Provincial Departments of Agriculture during the year amounted to Rs. 93,95,629 as

against Rs. 1,04,78,701 during 1921-22. The details are given below :—

| | Rs. |
|---|---|
| Bengal | 10,02,777 |
| Bihar and Orissa | 5,02,552 |
| United Provinces | 19,24,690 |
| Punjab | 14,33,289 |
| Bombay | 14,77,958 |
| Madras | 11,59,428 |
| Central Provinces | 9,09,803 |
| Burma | 6,50,220 |
| Assam | 2,58,060 |
| North-West Frontier Province | 57,312 |
| Baluchistan | 19,540 |
| TOTAL | 93,95,629 |

The reduction of nearly eleven lakhs of rupees is due to the activities of the retrenchment committees appointed in various provinces. It is regrettable that a department, whose sole object is the improvement of the basic industry of the country, should be hampered by the want of funds, and it is to be sincerely hoped that the set-back is only temporary. The scope for and prospects of agricultural improvement in India are greater by far than was ever imagined. Agricultural research is known to be expensive, but in no other country in the world has the cost on its Agricultural Department been more productive, the results being far in excess of the expenditure involved.

# APPENDIX I.

*Areas under improved varieties of crops during the year 1922-23.*

| Name of Province | Name of crop | Advantages | Area in acres | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1921-22 | | | 1922-23 | | | |
| | | | Departmental seed | Natural spread | Total | Departmental seed | Natural spread | Total | |
| Bengal | Paddy (Kataktara, Indrasail and Nagra). | Heavy yield | 21,073 | 86,846 | 107,919 | 26,615 | 140,372 | 166,987 | |
| | Jute (Green *olitorius*, Kakya Bombai, R 85 and R 86). | Give finer quality and greater quantity of fibre. | 54,697 | 104,612 | 159,309 | 71,470 | 157,343 | 228,813 | |
| | Sugarcane (Tanna) | Yields greater quantity of *gur* | 186 | 4,339 | 4,525 | 421 | 9,387 | 9,808 | |
| | Groundnut | Yields handsome profit | 41 | 571 | 612 | 131 | 402 | 533 | |
| | Wheat (Pusa 12) | Has good milling qualities | 25 | 161 | 186 | 37 | 180 | 217 | |
| | Potato (Darjeeling, Naini Tal and Shillong). | Better yield | 42 | 7,976 | 8,018 | 53 | 8,446 | 8,499 | |
| Bihar and Orissa | Paddy (Dahia, Types I & II and C. P. Fine). | Earliness and heavy yielders | 12 | 1,010 | 1,022 | 1,270 | 4,580 | 5,850 | |
| | Sugarcane (Coimbatore seedlings, Mungo, Saretha, Java 247 & Java Hebbal). | Cheaper in cultivation, heavy yielders and tillers. | 118 | 211 | 349 | 171* | 2,110 | 2,281 | * Including Coimbatore seed cane sufficient to plant 125 acres supplied by the Sugar Bureau. |
| | Groundnut | A profitable crop. Grows even on high poor lands. | .. | 11 | 11 | .. | 122 | 122 | |

*Areas under improved varieties of crops during the year 1922-23*—contd.

| Name of Province | Name of crop | Advantages | Area in acres | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1921-22 | | | 1922-23 | | | |
| | | | Departmental seed | Natural spread | Total | Departmental seed | Natural spread | Total | |
| United Provinces | Wheat (Pusa 4, 12, Cawnpore 13, Muzaffarnagar). | High yielding, rust resisting | 120,526 | 129,244 | 249,770 | 139,546 | 132,800 | 272,346 | These wheats have spread so widely that it is impossible to give exact figures. |
| | Cotton (Cawnpore-American, J. N. 1, Aligarh white-flowered and K 22). | Superior to *desi* cotton, better lint and higher ginning percentage. | 32,275 | 51,000 | 83,275 | 75,120 | 50,000 | 125,120 | |
| | Sugarcane (S 39, 42 and 48 and Mauritius). | Gives more outturn of cane per acre and about 50 per cent. of *gur* more than the local canes. | 1,835 | 160 | 1,995 | 6,330 | .. | 6,330 | |
| | Barley | Better yielder than local varieties | 20,000 | 4,000 | 24,000 | 15,000 | 8,200 | 23,200 | |
| | Gram | Produce and quality better than local varieties. | 10,070 | 2,028 | 12,098 | 14,070 | 16,955 | 31,025 | |
| | Miscellaneous | Better yielders than local varieties | 17,120 | 6,880 | 24,000 | 26,851 | 12,045 | 38,896 | |
| Punjab | Wheat (Punjab 11, 17, 8a, Pusa 4 & 12). | More yield, fetch better price, possess good milling and baking qualities, ripen early. | 45,093 | 764,674 | 809,767 | 86,233 | 827,276 | 913,509 | The areas under Punjab 11 and 8a are so widespread that it is no longer possible to give exact figures. |
| | Cotton— | | | | | | | | |
| | American 4 F | Long-stapled variety which yields more than *desi* cottons. Fetches a premium of Rs. 3—6 per maund of seed-cotton. | 94,171 | 283,547 | 377,718 | 117,150 | 318,325 | 435,475 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bombay | American 285 F | Spins finer than 4 F and also more drought resistant and earlier. | 2,003 | 7,175 | 9,178 | 4,880 | 16,020 | 20,900 |
| | Desi No. 24 | Improved *desi* variety | 260 | .. | 260 | 1,000 | .. | 1,000 |
| | White-flowered Neglectum. | More yield and higher lint percentage | 22,126 | .. | 22,126 | 32,405 | .. | 32,405 |
| | Sugarcane (Behar and Coimbatore 205). | High yield | 5 | 1,000 | 1,005 | 72 | 5,014 | 5,086 |
| | Cotton— | | | | | | | |
| | 1027 A. L. F. | The lint is sold at a premium | 98,000 | 200,000 | 298,000 | 140,500 | 250,000 | 390,500 |
| | Neglectum roseum | Heavy yield, pure type, better ginning percentage. | .. | .. | 5,000 | 27,762 | 200,000 | 227,762 |
| | Dharwar Nos. 1 & 3 | Give increased profit | 5,627 | 26,673 | 32,300 | 5,730 | 38,395 | 44,125 |
| | Gadag No. 1 | | 3,965 | 30,025 | 34,000 | 7,136 | 38,320 | 45,456 |
| | American | Prolific, early and hardy | 3,000 | .. | 3,000 | 1,000 | 6,000 | 7,000 |
| | Desi 27 W. N. | Prolific, special rough feel, bright colour | 200 | .. | 200 | 700 | .. | 700 |
| | Groundnut | Gives increased profit, matures early | 35 | 91,492 | 91,527 | 75 | 116,234 | 116,309 |
| | Sugarcane (Red Mauritius). | Gives about 15 per cent. better yield with the advantage of ratoon crops. | 140 | 660 | 800 | 125 | 1,275 | 1,400 |
| | Bajra (Akola variety) | Better quality grain and higher yield | .. | 13,000 | 13,000 | 50 | 44,000 | 44,050 |
| | Wheat (Pusa 4 and 12) | Better yield and less affected by smut | 331 | 510 | 842 | 1,855 | 1,030 | 2,885 |
| | Rice (various selected strains of Kolamba). | Higher yielding capacity | .. | .. | 76 | .. | .. | 1,200 |
| Madras | Paddy | Better yielders and more profitable to cultivators. | 22,593 | 65,332 | 87,925 | 24,610 | 153,562 | 178,172 |
| | Sugarcane | Do. do. | 2,389 | 6,125 | 8,514 | 2,486 | 4,553 | 7,039 |
| | Cotton | Do. do. | 39,904 | 64,137 | 104,041 | 61,554 | 89,192 | 151,746 |
| | Miscellaneous | Do. do. | 23,440 | 8,352 | 31,792 | 12,779 | 10,445 | 23,224 |
| Central Provinces | Wheat | Better yielders | .. | .. | 40,599 | .. | .. | 60,222 |
| | Paddy | Do. | .. | .. | 61,768 | .. | .. | 69,776 |
| | Cotton | Do. | .. | .. | 248,837 | .. | .. | 281,224 |
| | Juar | Do. | .. | .. | 30,781 | .. | .. | 21,531 |
| | Groundnut | Do. | .. | .. | 3,840 | .. | .. | 10,671 |
| | Other crops | Do. | .. | .. | 4,160 | .. | .. | 3,306 |

*Areas under improved varieties of crops during the year 1922-23*—concld.

| Name of Province | Name of crop | Advantages | Area in acres | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1921-22 | | | 1922-23 | | | |
| | | | Departmental seed | Natural spread | Total | Departmental seed | Natural spread | Total | |
| Burma | Paddy | Uniformity and freedom from red gram. High milling capacity. | .. | .. | 73,135 | .. | .. | 100,000 | |
| | Groundnut | High oil capacity. Earlier. Easy to harvest | .. | .. | 2,152 | .. | .. | 5,000 | |
| | Cotton (Indigenous selection and Cambodia). | More profitable to cultivate | .. | .. | 847 | .. | .. | 6,000 | |
| | Gram | Immunity to wilt disease | .. | .. | 2,500 | .. | .. | 30,000 | |
| Assam | Paddy | Higher yielders than *desi* varieties | .. | .. | 4,184 | .. | .. | 9,011 | |
| | Jute | | .. | .. | 892 | .. | .. | 1,207 | |
| | Sugarcane | | .. | .. | 443 | .. | .. | 2,055 | |
| | Potato | | .. | .. | 228 | .. | .. | 183 | |
| North-West Frontier Province. | Wheat (Pusa 4) | Ripens early, does not lodge, resists rust | .. | .. | 150,000 | .. | .. | 200,000 | |
| | Sugarcane (Red Assami) | Ripens early, vigorous in growth, little affected by disease or borers. | .. | .. | 16 | .. | .. | 50 | |
| | Berseem | Yields better than shaftal | .. | .. | 120 | .. | .. | 400 | |
| | Fruits (peach, plum, pear and apricot). | Superior quality | .. | .. | 200 | .. | .. | 250 | |

## APPENDIX II.

*List of Agricultural Stations in British India in 1922-23.*

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| | Pusa, Bihar | 750 | Overseer | Imperial Agriculturist, Agricultural Research Institute, Pusa. | Under the Imperial Department of Agriculture. |
| Bombay | Surat | 292 | Superintendent | Deputy Director of Agriculture, Gujarat, Surat. | |
| | Amalsad | 19 | Overseer | | |
| | Nadiad | 44 | Tobacco Breeder | | |
| | Broach | 24 | Superintendent | | |
| | Dohad | 57 | Ditto | | |
| | Dhulia | 28 | District Agricultural Overseer. | Deputy Director of Agriculture, North Central Division, Nasik. | |
| | Jalgaon | 214 | Superintendent | | |
| | Kopargaon | 115 | Ditto | Deputy Director of Agriculture, South Central Division, Poona. | Mainly a fodder farm for famine use. (A small portion is utilized as a sugarcane station.) |
| | Baramati | 21 | Ditto | | Sugarcane farm. |
| | Manjri | 62 | Ditto | | Sugarcane experimental station. |

*List of Agricultural Stations in British India in 1922-23*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bombay—*concld.* | Dharwar | 134 | Superintendent | Deputy Director of Agriculture, Southern Division, Dharwar. | Proposed to be abandoned. |
| | Gadag | 50 | Ditto | | |
| | Gokak Canal | 62 | Ditto | | |
| | Tegur | 370 | Fieldman | | |
| | Chharodi | 2,300 | Manager | Deputy Director of Agriculture for Animal Breeding, Poona. | Cattle-breeding farms. |
| | Bankapur | 112 | Ditto | | |
| | Karachi (Lord Willingdon cattle farm). | ... | Ditto | | |
| | Alibag | 72 | Superintendent | Deputy Director of Agriculture, Konkan, Ratnagiri. | Abandoned. |
| | Ratnagiri | 93 | Ditto | | |
| | Kumta | 184 | Ditto | | |
| | Karjat | 6 | Rice Specialist | | Rice research station. |
| | Karjat | 9 | Superintendent | Plant Breeding Expert, Poona. | Rice-breeding station. |
| | Mirpurkhas | 200 | Ditto | | Seed farm. |
| | Mirpurkhas | 60 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| | Sukkur | 30 | Ditto | Deputy Director of Agriculture, Sind, Karachi. | Proposed to be utilized as an adjunct to the Lord Willingdon Cattle Farm near Karachi. |
| | Larkana | 65 | Ditto | | |
| | Landhi | 24 | Ditto | | |
| | Jacobabad | 300 | Ditto | | |
| | Ganeshkhind, Kirkee | 80 | Ditto | Horticulturist to Government, Poona. | Agricultural and botanical station. Horticultural course is given here. |
| | Modi Bag, Poona | 14 | Ditto | | Teaching garden. |
| | Poona | 185 | Professor of Agriculture, Poona. | Professor of Agriculture, Poona Agricultural College. | Agricultural College farm. |
| | Kirkee | 362 | Manager | | Agricultural College dairy. |
| | Coimbatore | 450 +42 | Manager | Superintendent, Central Farm, Coimbatore. | Central farm attached to the Agricultural College. |
| | Samalkota | 67 | Ditto | Deputy Director of Agriculture, I Circle, Cocanada. | |
| | Anakapalle | 40 | Ditto | | |
| | Guntur | 150 | Ditto | Deputy Director of Agriculture, II Circle, Guntur. | |
| Madras | Hagari | 224 | Ditto | Deputy Director of Agriculture, III Circle, Bellary. | |
| | Nandyal | 88 | Ditto | | |
| | Palur | 52 | Ditto | Deputy Director of Agriculture, IV Circle, St. Thomas's Mount. | |
| | Gudiyattam | 18 | Ditto | | Demonstration farm, since abolished. |

*List of Agricultural Stations in British India in 1922-23*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Madras—*concld.* | Koilpatti | 140 | Manager | Deputy Director of Agriculture, VI Circle, Madura. | |
| | Kasargod | 55 | Ditto | Deputy Director of Agriculture, VII Circle, Tellicherry. | West Coast coconut station. |
| | Taliparamba | 85 | Ditto | | |
| | Anamalai | 40 | Ditto | Deputy Director of Agriculture, VIII Circle. | Cotton farm, since abolished. |
| | Nanjanad, The Nilgiris | 90 | Ditto | | Seed potato farm. |
| | Tenmalai (Travancore) | 20 | Ditto | Deputy Director of Agriculture, Planting Districts, Coimbatore. | Rubber stations. |
| | Mooply (Cochin) | 20 | Ditto | | |
| | Sidapur (Coorg) | 19 | Ditto | | Coffee station. |
| | Peermade (Travancore) | 20 | Ditto | | Tea station. |
| | Chintaladevi | 850 | Ditto | Deputy Director of Agriculture for Live-stock, Coimbatore. | Cattle farm. |
| | Coonoor | ... | Assistant Farm Manager | Curator, Government Botanic Gardens and Parks, Ootacamund. | Pomological station. |
| | Dacca | 354 | Superintendent | Deputy Director of Agriculture, Eastern Circle. | |
| | Mymensingh | 20 | District Agricultural Officer. | | |
| | Comilla | 20 | Ditto | | |
| | Barisal | 20 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| Bengal | Jamalpur (Mymensingh) | 150 | Ditto | Deputy Director of Agriculture, Eastern Circle. | |
| | Dhanbari | 7 | Ditto | | |
| | Kishoreganj | 200 | Ditto | | |
| | Rajshahi | 63 | Superintendent | Deputy Director of Agriculture, Northern Circle. | |
| | Rangpur | 333 | Ditto | | Cattle farm. |
| | Rangpur | 19 | District Agricultural Officer | | Demonstration farm. |
| | Burirhat (Rangpur) | 52 | Superintendent | | Tobacco farm. |
| | Bogra | 23 | District Agricultural officer | | |
| | Pabna | 20 | Ditto | | |
| | Chinsura | 210 | Superintendent | Deputy Director of Agriculture, Western Circle. | |
| | Burdwan | 32 | Ditto | | |
| | Jessore | 20 | District Agricultural Officer | | |
| | Gosaba | 10 | Superintendent | Deputy Director, Western Circle, and Superintendent, Burdwan Division. | |
| | Berhampore | 45 | District Agricultural officer | | |
| | Bankura | 29 | Ditto | | |
| | Suri | 33 | Ditto | | |
| | Kalimpong | 76 | Manager | Director of Agriculture, Bengal. | |
| | Kalimpong, Kurseong and Berhampore. | ... | Superintendent of Sericulture. | Deputy Director of Sericulture. | Sericultural research stations. |
| Bihar and Orissa | Sabour | 190 | Manager | Professor of Agriculture. | Home farm attached to the Sabour College. |
| | Jamui | 39 | Inspector | | |

*List of Agricultural Stations in British India in 1922-23*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Bihar and Orissa—*concld.* | Ranchi (Kanke) | 140 | Manager | Deputy Director of Agriculture, Chota Nagpur Circle, Ranchi. | Potato farm. |
| | Neterhat | 193 | Inspector | | |
| | Purulia | 52 | Overseer | | |
| | Ramgarh | 43 | Ditto | | |
| | Sambalpur | 32 | Inspector | | |
| | Cuttack | 150 | Manager | Deputy Director of Agriculture, Orissa Circle, Cuttack. | |
| | Khurda | 31 | Overseer | | |
| | Balasore | 80 | Ditto | | |
| | Angul | 25 | Ditto | Deputy Commissioner, Angul. | Private demonstration farm under the supervision of the Deputy Director of Agriculture, Orissa Circle. |
| | Sipaya | 379 | Deputy Director of Agriculture, North Bihar Range, Sipaya. | ..... | Cattle-breeding farm and sugarcane station. |
| | Cawnpore | 58 | Superintendent | | |
| | Kalianpur (Cawnpore) | 260 | Overseer | | |
| | Orai (Jalaun) | 87 | Superintendent | | Now closed. |
| | Atarra (Banda) | 171 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| United Provinces | Etawah | 62 | Ditto | Deputy Director of Agriculture, Central Circle, Cawnpore, and Divisional Superintendent of Agriculture. | |
| | Hardoi | 40 | Ditto | | |
| | Mainpuri | 53 | Ditto | | |
| | Jaitpur (Hamirpur) | 31 | Overseer | | |
| | Partabgarh | 90 | Superintendent | Deputy Director of Agriculture, Eastern Circle, Partabgarh. | |
| | Naugawan (Sultanpur) | 386 | Ditto | | |
| | Fyzabad | 206 | Ditto | | |
| | Benares | 78 | Ditto | Divisional Superintendent of Agriculture. | |
| | Aligarh | 88 | Ditto | Deputy Director of Agriculture, Western Circle, Aligarh, and Divisional Superintendent of Agriculture. | Now closed. |
| | Muzaffarnagar | 109 | Ditto | | |
| | Muttra | 56 | Inspector | | |
| | Agra | 100 | Ditto | | |
| | Saharanpur | 39 | Superintendent | | |
| | Bulandshahr | 25 | Inspector | | |
| | Aligarh (Kalai) | 142 | Superintendent | | |
| | Gorakhpur | 110 | Overseer | Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur. | |
| | Bahraich | 21 | Ditto | | |
| | Shahjahanpur | 164 | Superintendent | Deputy Director of Agriculture, Rohilkhand Circle. | |
| | Nawabganj (Bareilly) | 119 | Ditto | | |

*List of Agricultural Stations in British India in 1922-23*—contd.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Punjab | Lyallpur— | | | | |
| | Agricultural Farm | 473 | Manager | Professor of Agriculture, Punjab, Lyallpur. | |
| | Students' Farm | 78 | | | |
| | Botanical Farm | 120 | | Economic Botanist to Government, Punjab, Lyallpur. | |
| | Montgomery | 250 | Ditto | Professor of Agriculture, Lyallpur, and Extra Assistant Director of Agriculture. | Mainly a seed farm. |
| | Gurdaspur | 161 | Manager | Deputy Director of Agriculture, 1st Circle. | Experimental Station. |
| | Sargodha | 157 | Ditto | | Seed farms |
| | Chillianwalla | 250 | Ditto | | |
| | Beas | 43 | Ditto | | |
| | Hansi | 589 | Ditto | Deputy Director of Agriculture, 2nd Circle. | Experimental Station. |
| | Harappa Road | 558 | Extra Assistant Director of Agriculture. | Agricultural Chemist, Punjab. | For reclamation of saline soils. |
| | Mandalay | 619 | Superintendent | Deputy Director of Agriculture, Northern Circle. | |
| | Padu | 29 | Senior Agricultural Assistant. | | |
| | Hopin | 33 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| Burma | Tatkon | 45 | Superintendent, Senior Agricultural Assistant. | Deputy Director of Agriculture, East Central Circle. | |
| | Yawnghwe | 36 | Ditto | | |
| | Mahlaing | .. | Superintendent, Assistant Director of Agriculture. | Deputy Director of Agriculture, Myingyan Circle. | |
| | Taungtha | 16 | Junior Agricultural Assistant. | | |
| | Allanmyo | 143 | Superintendent, Senior Agricultural Assistant. | Deputy Director of Agriculture, West Central Circle. | |
| | Pwinbyu | 22 | Junior Agricultural Assistant. | | |
| | Hmawbi | 454 | Superintendent, Senior Agricultural Assistant. | Deputy Director of Agriculture, Southern Circle. | |
| | Nyaunglebin | 16 | Junior Agricultural Assistant. | | |
| | Zigon | 21 | Ditto | | |
| | Akyab | 128 | Superintendent, Senior Agricultural Assistant. | Deputy Director of Agriculture, Arakan Circle. | |
| Central Provinces | Nagpur | 268 | Superintendent | Principal, Agricultural College, Nagpur. | College farm. |
| | Akola | 271 | Ditto | Economic Botanist, Nagpur. | |
| | Borgaon | 368 | Ditto | Deputy Director of Agriculture, Western Circle, Amraoti. | |
| | Yeotmal | 106 | Ditto | | |
| | Khandwa | 177 | Ditto | | |
| | Basim | 109 | Ditto | | |

*List of Agricultural Stations in British India during 1922-23*—concld.

| Name of Province | Name of the Agricultural Station | Area in acres | Officer in immediate charge | Supervising Officer | Remarks |
|---|---|---|---|---|---|
| Central Provinces —*concld.* | Sindewahi | 197 | Superintendent | Deputy Director of Agriculture, Southern Circle, Nagpur. | |
| | Tharsa | 116 | Ditto | | |
| | Wara-Seoni | 63 | Ditto | | |
| | Telinkheri | 1,000 | Ditto | Deputy Director of Agriculture in charge Animal Husbandry, Nagpur. | Dairy farm. |
| | Raigarh (Gorhi) | 1,200 | Ditto | | Cattle-breeding farm. |
| | Chandkhuri | 333 | Ditto | Deputy Director of Agriculture, Eastern Circle, Raipur. | |
| | Bilaspur | 253 | Ditto | | |
| | Drug | 281 | Ditto | | |
| | Raipur | 229 | Ditto | | |
| | Powarkhera (Hoshangabad). | 528 | Ditto | Assistant Director of Agriculture, Chhindwara. | |
| | Seoni | 164 | Ditto | | |
| | Chhindwara | 69 | Ditto | | |
| | Betul | 161 | Ditto | | |
| | Adhartal (Jubbulpore) | 637 | Ditto | Deputy Director of Agriculture, Northern Circle, Jubbulpore. | |
| | Saugor | 161 | Ditto | | |
| | Damoh | 152 | Ditto | | |

| | | | | | |
|---|---|---|---|---|---|
| Assam | Jorhat | 59 | Manager | Deputy Director of Agriculture, Assam Valley. | Sugarcane station. |
| | Titabor | 120 | Ditto | | Rice station. |
| | Upper-Shillong | 367 | Ditto | Deputy Director of Agriculture, Surma Valley and Hill Districts. | Potato station. |
| | Karimganj | 80 | Ditto | | Rice station. |
| North-West Frontier Province. | Tarnab (Peshawar) | 200 | Ditto | Agricultural Officer, North-West Frontier Province, Peshawar. | |
| | Haripur | 20 | Ditto | | |

## APPENDIX III.

*Showing results of well-boring during 1922-23.*

| Name of Province | 1922-23 | | 1921-22 | |
|---|---|---|---|---|
| | Number of bores | Number successful | Number of bores | Number successful |
| United Provinces | 624 | 457 | 591 | 393 |
| Punjab | 301 | 245 | 344 | 287 |
| Bombay | 80 | 46 | 131 | 78 |
| Madras | 505 | 278 | 451 | 215 |
| Central Provinces | 21 | 15 | 4 | .... |
| Bengal | 5 | 5 | .... | .... |
| Bihar & Orissa | 114 | 84 | 72 | 58 |

# APPENDIX IV.

*Showing sale of improved implements through departmental agency during 1922-23.*

| Name of Province. | Ploughs | | Cane Mills | | Fodder Cutters | | Hoes | | Other Implements | | Spare Parts | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1922-23 | 1921-22 | 1922-23 | 1921-22 | 1922-23 | 1921-22 | 1922-23 | 1921-22 | 1922-23 | 1921-22 | 1922-23 | 1921-22 |
| United Provinces | 1,318 | 1,082 | 49 | 81 | 18 | 64 | 83 | 55 | 176 | 116 | 2,433 | 1,411 |
| Punjab | 2,683 | 1,664 | 533 | .. | 224 | 182 | 80 | 16 | 515 | 320 | 709 | 2,789 |
| Bombay | 782 | 418 | 16 | 6 | .. | 1 | 7 | .. | 1,192 | 687 | 72 | .. |
| Madras | 613 | 198 | 85 | 95 | .. | 13 | 7 | 2 | 98 | 52 | 28 | .. |
| Central Provinces | 1,983 | 1,028 | 112 | 87 | 8 | 14 | 143 | 56 | 291 | 107 | 2,345 | 1,277 |
| Bengal | 16 | 23 | 2 | .. | .. | .. | 34 | 25 | 3 | 1 | .. | 31 |
| Assam | 6 | 2 | 206 | 159 | .. | .. | 4 | .. | 74 | 53 | .. | .. |
| Burma | 10 | 15 | .. | 4 | .. | .. | .. | .. | 2 | 3 | 21 | 9 |

# APPENDIX V.

## *Agricultural Colleges and Schools in British India during 1922-23.*

| Name of College or School | Courses of instruction | 1922-23 | | | | 1921-22 | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Applications for admission | Admissions made during the year | Total number on the roll | Number passed in final examination | Applications for admission | Admissions made during the year. | Total number on the roll | Number passed in final examination | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | | | | *(a) Post-graduate Training Institution.* | | | | | |
| Agricultural College, Pusa | Post-graduate | 7 | 7 | 11 | 5 | 4 | 4 | 12 | 8 | In addition, 12 students received short courses of training in 1922-23 as against 3 in 1921-22. |
| | | | | | *(b) Provincial Agricultural Colleges.* | | | | | |
| Poona Agricultural College. | (1) Three-year B. Ag. Degree course. | | | | 38 | | | | 44 | Affiliated to the University of Bombay. |
| | (2) College Diploma course. | 99 | 53 | 161 | 5 | 97 | 71 | 189 | 4 | |
| | (3) One-year Special course. | .. | .. | .. | 5 | .. | .. | .. | 5 | |
| Agricultural College Coimbatore. | (1) Degree course—3 years. | 126 | 20 | 14 | 11 | .. | .. | .. | .. | Affiliated to the University of Madras. |
| | (2) Old Diploma course —3 years. | .. | .. | 18 | 18 | 93 | 19 | 19 | 17 | |
| | (3) Certificate course—2 years. | 88 | 27 | 43 | 16 | 95 | 23 | 44 | 19 | |
| Agricultural College, Nagpur. | (1) Three and half years' Diploma course for the Licentiate of Agriculture. | 72 | 35 | 58 | 5 | .. | .. | .. | 3 | |
| | (2) Two years' Certificate course. | | 11 | 17 | 17 | 73 | 38 | 52 | 9 | |
| Agricultural College, Sabour. | Two years' Certificate course. | .. | .. | 26 | 25 | 92 | 34 | 57 | 14 | Closed since April 1923. |
| Agricultural College, Cawnpore. | (1) Diploma (L.AG.) course of 4 years. | 74 | 34 | 64 | 8 | 63 | 31 | 51 | 5 | |
| | (2) Two years' or Vernacular course. | 109 | 36 | 59 | 27 | 124 | 36 | 52 | 17 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Punjab Agricultural College, Lyallpur. | (1) B.Sc. Agri. course—4 years.<br>(2) M.Sc. Agri. course<br>(3) Leaving Certificate course—2 years. | 300 | 53 | 145 | 30 | 228 | 54 | 150 | 34 | Affiliated to the Punjab University. |
| | (4) Vernacular course—6 months. | 32 | 30 | 24 | 24 | 34 | 25 | 24 | 24 | |
| | (5) Rural Economy course—one month. | .. | 20 | 20 | 20 | .. | 22 | 22 | 22 | |
| | (6) Teachers' Training course—10½ months. | .. | 12 | 12 | 12 | .. | 17 | 17 | 17 | |
| *Bengal.* | | | | (c) *Agricultural High and Middle Schools.* | | | | | | |
| Secondary Agricultural School, Dacca. | The new curriculum includes agriculture, rural engineering, veterinary hygiene, book-keeping and rural economics. | 276 | 13 | 10 | .. | .. | 20 | 16 | 11 | |
| Secondary Agricultural School, Chinsura. | | .. | 27 | 16 | 16 | .. | 20 | 12 | .. | |
| Amarpur Middle English School, District Burdwan. | Students are taught agriculture, both theoretical and practical. | .. | 22 | 95 | 32 | .. | .. | 39 | 13 | |
| Durgapur High English School, District Chittagong. | Ditto | 9 | 9 | 55 | 33 | 16 | 16 | 59 | 37 | |
| *Central Provinces.* | | | | | | | | | | |
| Agricultural Middle School, Powarkhera. | 2 years' course | 8 | 8 | 12 | 4 | 11 | 11 | 6 | 5 | |
| Agricultural Middle School, Chandkhuri. | Ditto | 3 | 3 | 7 | 3 | 10 | 10 | 18 | 8 | |
| *Madras.* | | | | | | | | | | |
| Agricultural Middle School, Taliparamba. | 2 years' course in vernacular. | 18 | 18 | 18 | .. | .. | .. | .. | .. | Newly started in 1922-23. |
| Agricultural Middle School, Anakapalle. | Ditto | 7 | 7 | 7 | .. | .. | .. | .. | .. | |
| *Burma.* | | | | | | | | | | |
| Agricultural School, Pyinmana. | 4 years' course | 39 | 39 | 29 | .. | .. | .. | .. | .. | Newly started on 6th June 1923 and is run by the American Baptist Mission. |

## *List of Agricultural Colleges and Schools in British India during 1922-23*—concld.

| Name of College or School | Courses of instruction | 1922-23 | | | | 1921-22 | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Applications for admission | Admissions made during the year | Total number on the roll | Number passed in final examination | Applications for admission. | Admissions made during the year | Total number on the roll | Number passed in final examination | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| *Bombay.* | | | | | (*d*) *Vernacular Agricultural Schools.* | | | | | |
| Vernacular Agricultural School, Loni Kalbhor (in Marathi). | 2 years' course . . | 61 | 27 | 49 | 22 | 57 | 27 | 49 | 22 | |
| Vernacular Agricultural School, Devi-hosur (in Kanarese). | Ditto . . | 30 | 10 | 21 | 10 | 41 | 13 | 24 | 13 | Practical training in weaving, rope making, etc., is also given. |
| Lord Willingdon Vernacular Agricultural School, Veshvi, Kolaba (in Marathi). | Ditto . . | .. | .. | .. | .. | 15 | 10 | 12 | 3 | Abolished in 1922-23. |
| Vernacular Agricultural School, Jambul (in Marathi). | Ditto . . . | 5 | 5 | 25 | 13 | 31 | 22 | 29 | 6 | |
| Vernacular Agricultural School, Godhra (in Gujarati). | Ditto . . . | 35 | 15 | 28 | 11 | 50 | 14 | 31 | 17 | |
| Vernacular Agricultural School, Dhulia, West Khandesh (in Marathi). | Ditto . . . | 40 | 20 | 17 | .. | .. | .. | .. | .. | Newly started. |
| *Central Provinces.* | | | | | | | | | | |
| Vocational class, Akola . | 6 months' course . | 11 | 11 | 11 | 11 | .. | .. | .. | .. | Ditto. |
| *Bihar and Orissa.* | | | | | | | | | | |
| Vernacular Agricultural School, Pathra (Godda), District Santal Parganas. | Practical training in general agriculture, spinning etc. | .. | .. | 75 | .. | .. | .. | .. | .. | Attached to the C. M. S. Mission Upper Primary School. |
| *United Provinces.* | | | | | | | | | | |
| Vernacular Agricultural School, Bulandshahr. | 2 years' course . | 49 | 24 | 48 | 24 | 41 | 33 | 33 | .. | No examination held in 1921-22. |

## APPENDIX VI.

### *Operations of Non-Credit Agricultural Co-operative Societies in British India during 1922-23.*

The two tables below include Agricultural Societies for—

A. 1. *Purchase, and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY.

*Operations of Non-Credit Agricultural Co-operative Societies in British India during 1922-23*—contd.

(A) *Purchase, Sale and Production.*

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Bombay | Purchase and Purchase and Sale. | 88 | 3,977 | 74,950 | 21,033 | 1,74,526 | +3,586 | |
| | Production | 18 | 528 | 8 | ... | 13,115 | —58 | |
| | Production and Sale | 47 | 5,705 | 1,54,922 | 3,69,956 | 2,79,925 | +18,746 | |
| | Others | 6 | 23 | ... | ... | 53,058 | +291 | |
| | TOTAL | 159 | 10,233 | 2,29,880 | 3,90,989 | 5,20,624 | +22,565 | |
| Madras | Purchase and Purchase and Sale. | 77 | 8,091 | 2,27,565 | 1,53,832 | 4,01,986 | +12,793 | |
| | Production and Sale | 4 | 267 | ... | ... | 1,03,506 | +2,083 | |
| | Others | 14 | 1,227 | ... | ... | 9,489 | +295 | |
| | TOTAL | 95 | 9,585 | 2,27,565 | 1,53,832 | 5,14,981 | +15,171 | |
| Bengal | Purchase and Purchase and Sale. | 21 | 4,147 | 1,44,441 | ... | 1,54,641 | +5,910 | |
| | Production | 114 | 4,689 | ... | ... | 77,658 | —1,962 | |
| | Production and Sale | 55 | 5,284 | 11,49,783 | 6,12,494 | 5,78,575 | +3,45,814 | |
| | Others | 12 | 172 | 233 | 146 | 1,092 | +229 | |
| | TOTAL | 202 | 14,292 | 12,94,457 | 6,12,640 | 8,11,966 | +3,49,991 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bihar and Orissa. | Purchase and Purchase and Sale. | 8 | 375 | 9,361 | ... | 9,986 | ... |
| | Production and Sale . . | 26 | 327 | 10,056 | 2,624 | 22,253 | —5,987 |
| | TOTAL . | 34 | 702 | 19,417 | 2,624 | 32,239 | —5,987 |
| United Provinces. | Purchase and Purchase and Sale. | 1 | 73 | ... | .... | 7,290 | —192 |
| | Production . | 1 | 58 | ... | ... | 1,656 | —934 |
| | Production and Sale . . | 7 | 280 | 13 | 4,888 | 26,744 | +1,008 |
| | TOTAL . | 9 | 411 | 13 | 4,888 | 35,600 | —118 |
| Punjab | Purchase and Purchase and Sale. | 22 | 1,072 | 25,596 | 23,941 | 33,615 | —4,339 |
| | Production . . . | 48 | 905 | ... | ... | 3,441 | —65 |
| | Production and Sale . . | 21 | 1,608 | 10,48,178 | 29,61,163 | 2,56,019 | +7,425 |
| | Others . . . . | 217 | 9,376 | ... | 16 | 16,382 | +4,854 |
| | TOTAL . | 308 | 12,961 | 10,73,774 | 29,85,120 | 3,09,457 | +7,875 |
| Burma | Purchase and Purchase and Sale. | 18 | 1,019 | 18,396 | ... | 16,663 | —2,089 |
| | Production . | 2 | 130 | ... | ... | ... | ... |
| | Production and Sale . | 74 | 6,947 | 9,18,474 | 9,40,011 | 9,02,704 | —1,02,860 |
| | TOTAL . | 94 | 8,096 | 9,36,870 | 9,40,011 | 9,19,367 | —1,04,949 |

## *Operations of Non-Credit Agricultural Co-operative Societies in British India during 1922-23*—concld.

### (A) *Purchase, Sale and Production*—concld.

| Province | Class of societies | Number of societies | Number of members | Sale of goods to members | Purchase of members' products | Working capital | Profit and loss for the year | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Rs. | Rs. | Rs. | Rs. | |
| Central Provinces and Berar. | Purchase and Purchase and Sale. | 6 | 469 | 14,384 | 328 | 21,930 | +4,208 | |
| | Production | 21 | 263 | 235 | ... | 1,511 | +444 | |
| | Production and Sale | 1 | 165 | ... | ... | 10,485 | +486 | |
| | TOTAL | 28 | 897 | 14,619 | 328 | 33,926 | +5,138 | |

### (B) *Cattle Insurance.*

| Province | Number of societies | Amount of risk insured | Premia collected during the year | Supplementary contribution collected | Number of animals | | Claims paid | Cost of management | Funds in hand at end of year | Amount of risk re-insured | Amount of premia paid for re-insurance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Insured | Lost | | | | | |
| | | Rs. | Rs. | Rs. | | | Rs. | Rs. | Rs. | Rs. | Rs. |
| Bombay | 9 | 12,010 | 485 | ... | 173 | 1 | ... | 103 | 964 | ... | ... |
| Punjab | 39 | 43,480 | 2,318 | 258 | 332 | 5 | 247 | 51 | 6,726 | 4,855 | 142 |
| | 1* | 4,855 | 142 | ... | 104 | ... | ... | ... | 1,201 | ... | ... |
| Burma | 397 | 1,05,171 | 3,605 | 89 | 2,305 | 42 | 1,880 | 309 | 35,323 | 53,807 | 1,638 |
| | 1* | 53,807 | 1,037 | ... | 2,418 | 73 | 840 | 556 | 15,850 | ... | ... |
| United Provinces | 1 | 1,709 | 38 | ... | 28 | ... | ... | ... | 58 | ... | ... |

* Central Re-insurance Society.

## APPENDIX VII.

*Showing the working of the Provincial Civil Veterinary Departments during 1922-23.*

| Province | Reported mortality | | | Dispensaries and hospitals | | District work | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rinderpest | Other diseases | Total | Hospitals and dispensaries | Cases treated and castrations performed | Cases treated and castrations performed | Outbreaks in which inoculation was undertaken | Deaths uninoculated | Inoculations | Deaths after inoculation |
| Bombay | 4,767 | 6,799 | 11,566 | 80 | 149,087 | 36,279 | 149 | 2,346 | 15,534 | 156 |
| Madras | 4,279 | 23,963 | 28,242 | 66 | 91,138 | 50,769 | 178 | 2,504 | 29,946 | 76 |
| Bengal | 20,431 | 3,590 | 24,021 | 41 | 59,696 | 81,986 | 952 | 18,097 | 15,007 | 1,017 |
| Bihar and Orissa | 22,365 | 8,446 | 30,811 | 26 | 37,749 | 81,818 | 1,100 | 8,068 | 159,325 | 626 |
| United Provinces | 7,266 | 6,988 | 14,254 | 121 | 179,209 | 77,211 | 435 | 4,969 | 49,002 | 62 |
| Punjab | 6,936 | 21,971 | 28,907 | 173 | 562,258 | 183,078 | 1,445 | 6,111 | 313,250 | 340 |
| Burma | 17,591 | 9,597 | 27,188 | 5 | 6,570 | 118,252 | 270 | 3,924 | 23,793 | 600 |
| Central Provinces | 1,725 | 5,666 | 7,391 | 84 | 215,449 | 136,396 | 140 | 1,169 | 12,975 | 53 |
| Assam | 8,229 | 17,080 | 25,309 | 3 | 4,645 | 62,964 | 276 | 3,650 | 21,996 | 153 |
| North-West Frontier Province | 232 | 7,270 | 7,502 | 18 | 55,113 | 25,750 | 113 | 104 | 28,410 | 6 |
| Sind | 4,401 | 1,087 | 5,488 | 17 | 25,786 | 2,443 | 58 | 970 | 8,706 | 81 |
| Baluchistan | 13 | 1,112 | 1,125 | 6 | 9,751 | 1,364 | 3 | 99 | 1,251 | 1 |
| Rajputana | | 126 | 126 | 2 | 2,426 | 700 | ... | ... | ... | .. |
| TOTAL FOR 1922-23 | 98,235 | 113,695 | 211,930 | 642 | 1,398,877 | 858,950 | 5,119 | 52,011 | 679,195 | 3,171 |
| TOTAL FOR 1921-22 | ... | ... | 237,332 | 616 | 1,242,751 | 768,984 | 5,191 | 63,023 | 715,691 | 2,367 |

## APPENDIX VIII.

*Showing the details as to students of Veterinary Colleges and Schools in India during 1922-23.*

| Veterinary College or School | Course of instruction | Number of students | | | | | | Students admitted during the year, classed by educational qualifications | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Admitted during the year | | Passed final examination during the year | Failed to pass final examination | Remaining under instruction at end of the year | | Matriculates, school finals or with higher qualifications | Knowing some English but not matriculates | Knowing no English or very little English |
| | | Scholarship-holders | Others | | | In ordinary course | Instruction prolonged by reason of failure to pass | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Bombay Veterinary College | 3 years' English course. | 11 | 9 | 9 | 5 | 50 | 12 | 5 | 15 | ... |
| Madras " " | Do. | 30 | 2 | 18 | 6 | 48 | 22 | 32 | ... | ... |
| Bengal " " | Do. | 31 | 13 | 33 | 10 | 72 | 27 | 32 | 12 | ... |
| Punjab " " | 3 years' Vernacular course. | ... | ... | 52 | 25 | ... | 23 | ... | ... | ... |
| | 4 years' English course. | 5 | 14 | ... | ... | 27 | 1 | 18 | 1 | ... |
| Insein Veterinary School | 3 years' Vernacular course. | 16 | 2 | 10 | ... | 45 | ... | ... | 1 | 44 |
| Taunggyi " " | 1½ Do. | 1 | 5 | 5 | ... | ... | ... | ... | 1 | 1 |

## APPENDIX IX.

*Showing the number of cattle issued from Government farms during 1922-23.*

| Province | Bulls | Cows | Male buffaloes | She buffaloes | Young stock | Total for 1922-23 | Total for 1921-22 | Remarks. |
|---|---|---|---|---|---|---|---|---|
| United Provinces | 52 | .. | 6 | .. | .. | 58 | 11 | |
| Punjab | 221 | .. | 12 | .. | 60 | 293 | 279 | |
| Bombay | 38 | 45 | 2 | .. | 57 | 142 | 131 | |
| Madras | 12 | .. | 1 | .. | 1 | 14 | 13 | |
| Central Provinces | 59 | 79 | 1 | 26 | 151 | 316 | 243 | |
| Bengal | 10 | .. | .. | .. | .. | 10 | 24 | |
| Bihar and Orissa | 37 | 8 | .. | .. | 9 | 54 | 47 | |
| Assam | 3 | .. | .. | .. | 1 | 4 | 7 | |
| North-West Frontier Province | 6 | 6 | .. | .. | .. | 12 | 10 | |
| Pusa | 23 | 11 | .. | .. | 58 | 92 | 117 | |

## APPENDIX X.

*List of Agricultural Publications in India during 1922-23.*

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE.** | | |
| 1 | The *Agricultural Journal of India*, Vol. XVII, Parts IV, V and VI, and Vol. XVIII, Parts I, II and III. Price R. 1-8 or 2*s.* per part; annual subscription R. 6 or 9*s.* 6*d.* | Edited by the Agricultural Adviser to the Government of India, Pusa. | Messrs. Thacker, Spink and Co., Calcutta. |
| 2 | Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert and the Secretary, Sugar Bureau) for 1921-22. Price As. 14. | Issued from the Agricultural Research Institute, Pusa. | Government Printing, India, Calcutta. |
| 3 | Review of Agricultural Operations in India, 1921-22. Price R. 1-4. | Agricultural Adviser to the Government of India, Pusa. | Ditto |
| 4 | Methods of Examination of Certain Characters in Cotton. Pusa Agricultural Research Institute Bulletin No. 138. Price As. 8. | G. R. Hilson, B.Sc., Cotton Specialist, Madras. | Ditto |
| 5 | Annual Report of the Board of Scientific Advice for India for 1921-22. Price R. 1. | Issued by the Board of Scientific Advice for India. | Ditto |
| 6 | Prices and Wages in India (thirty-seventh issue). Price Rs. 2. | Issued by the Department of Statistics, India. | Ditto |
| 7 | Estimates of Area and Yield of Principal Crops in India, 1921-22. Price As. 8. | Ditto | Ditto |
| 8 | Summary of Tables showing the total area, area cultivated and uncultivated, area under irrigation, and area under different crops, in British India in the agricultural year 1921-22. Price As. 4. | Ditto | Ditto |
| 9 | Estimates of Principal Crops in India, 1921-22. Price one-half anna. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 10 | Agricultural Statistics of British India, 1920-21, Vol I. Price Rs. 2-8. | Issued by the Department of Statistics, India. | Government Printing, India, Calcutta. |
| 11 | Agricultural Statistics of British India, 1920-21, Vol. II. Price R. 1-8. | Ditto | Ditto |
| 12 | Agricultural Statistics of Bengal for 1921-22. Price Rs. 1-12. | Government of Bengal, Agriculture and Industries Department. | Bengal Secretariat Book Depôt, Calcutta. |
| 13 | Report on the Operations of the Department of Agriculture, Bengal, for the year 1921-22. | Issued by the Department of Agriculture, Bengal. | Ditto |
| 14 | Proceedings of the meeting of the Board of Agricultural Department, Bengal, held on the 20th April 1922 (for official use only). | Ditto | Ditto |
| 15 | Report on the Crop Cutting Experiments during the quinquennium from 1917-18 to 1921-22. Price As. 9. | Ditto | Ditto |
| 16 | Cultivation of Jute for seed | R. S. Finlow, B.SC., F.I.C., Offg. Director of Agriculture, Bengal. | Ditto |
| 17 | *Bengal Agricultural Journal* (Quarterly). (In English and Bengali.) Annual subscription R. 1-4; single copy As. 5. | Issued by the Department of Agriculture, Bengal. | Sreenath Press, Dacca. |
| 18 | Report of the Department of Agriculture, Bihar and Orissa, for the year ending 30th June, 1922. Price As. 4. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Printing, Bihar and Orissa, Patna. |
| 19 | Season and Crop Report of Bihar and Orissa for 1922-23. Price R. 1. | Ditto | Ditto |
| 20 | Agricultural Statistics of Bihar and Orissa for 1921-22. Price Rs. 2-8. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 21 | Report on the Administration of the Department of Agriculture of the United Provinces of Agra and Oudh for the year ending 30th June, 1922. Price R. 1-2. | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 22 | Season and Crop Report of the United Provinces of Agra and Oudh for 1921-22. Price As. 14. | Issued by the Department of Land Records, United Provinces. | Ditto |
| 23 | Report on the Agricultural Stations in the Western Circle, United Provinces, for the year ending 31st May, 1922. Price R. 1. | Issued by the Department of Agriculture, United Provinces. | Ditto |
| 24 | Report on the Agricultural Stations in the Central Circle, United Provinces, for the year ending 30th June, 1922. Price R. 1. | Ditto | Ditto |
| 25 | Report on the Agricultural Stations in the North-Eastern Circle, United Provinces, for the year ending 30th June, 1922. Price As. 6. | Ditto | Ditto |
| 26 | Report on the Agricultural Stations in the Eastern Circle, United Provinces, for the year ending 30th June, 1922. Price As. 14. | Ditto | Ditto |
| 27 | Report on the Working and Administration of the United Provinces Government Gardens for the year 1921-22. | Ditto | Ditto |
| 28 | Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1922, Part I. Price R. 1. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 29 | Season and Crop Report of the Punjab for the year 1921-22. Price Rs. 1-8 or 2*s*. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 30 | Tables of Agricultural Statistics of the Punjab for the year 1921-22 | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 31 | Annual Report of the Lawrence Gardens, Lahore, for 1921-22. Price As. 2 or 2*d*. | Ditto | Ditto |
| 32 | Graphs of Humidities and Temperatures connected with the Report on the Census of the Failure of the Cotton Crop in the Punjab in 1919. | Ditto | Ditto |
| 33 | Pamphlet on Orange Culture in the Punjab. Price As. 5. | Ditto | Ditto |
| 34 | Report on the third regular Wages Survey of the Punjab taken in December 1922. Price R. 1-2. | Ditto | Ditto |
| 35 | Water Hyacinth (*Eichornia crassipes*). Punjab Department of Agriculture Leaflet No. 12. (Revised.) | Ditto | Ditto |
| 36 | Tractors and Tractor Implements. Punjab Department of Agriculture Leaflet No. 21 of 1923. | H. R. Stewart, Professor of Agriculture, and D. P. Johnston, Deputy Director of Agriculture, Lyallpur. | Ditto |
| 37 | Report on the complaints of the abnormal state of the Cotton crop in 1921. Price Rs. 4-10. | D. Milne, B.Sc., Economic Botanist, Punjab. | Ditto |
| 38 | Graphs of Humidities and Temperatures connected with the Report on the complaints of the abnormal state of the Cotton crop in 1921. | Ditto | Ditto |
| 39 | Report on the Cotton Survey of the Ludhiana District in 1920. Price Rs. 14. | L. Jai Chand Luthra, M.Sc., Offg. Economic Botanist, Punjab. | Ditto |
| 40 | Report on the Cotton Survey of the Shahpur District in 1916. Price Rs. 25. | D. Milne, B.Sc., Economic Botanist, Punjab. | Ditto |
| 41 | Report on the Cotton Survey in the Sialkot District. | D. Milne, B.Sc., Economic Botanist, Punjab. | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 42 | Report on the Wheat Survey in the Muzaffargarh District. | Agha Yusuf Ali Khan, Assistant to Economic Botanist to Government, Punjab. | Government Printing, Punjab, Lahore. |
| 43 | Annual Report of the Department of Agriculture, Bombay Presidency, for 1921-22. Price R. 1-5. | Issued by the Department of Agriculture, Bombay. | Yeravda Prison Press, Poona. |
| 44 | Season and Crop Report of the Bombay Presidency for 1921-22. Price As. 9-6. | Ditto | Government Central Press, Bombay. |
| 45 | Report of the Experimental Work of the Alibag Agricultural Station for the four years 1916-17 to 1919-20. Price As. 13. | Ditto | Ditto |
| 46 | The Crops of the Bombay Presidency, their Geography and Statistics. Bombay Department of Agriculture Bulletin No. 109 of 1921. Price Rs. 2-13. | P. C. Patil, Deputy Director of Agriculture, South Central Division, Bombay. | Ditto |
| 47 | Year Book of the Agricultural Department in the Southern Division. Bombay Department of Agriculture Bulletin No. 110 of 1922. Price As. 5. | Issued by the Department of Agriculture, Bombay. | Ditto |
| 48 | A Note on Well-boring. Bombay Department of Agriculture Bulletin No. 111 of 1923. Price As. 8. | W. M. Schutte, Agricultural Engineer to the Government of Bombay. | Ditto |
| 49 | Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1921-22. | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 50 | Season and Crop Report of the Madras Presidency for 1921-22. | Issued by the Board of Revenue, Madras. | Ditto |
| 51 | Year Book of the Madras Agricultural Department, for 1922. Price As. 10. | Issued by the Department of Agriculture, Madras. | Ditto |
| 52 | Villager's Calendar, 1923-24 | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 53 | **Annual Reports of Agricultural Stations of the Madras Presidency, 1922-23 (for official use only).** | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 54 | A Soil Survey of the Periyar Tract. Madras Department of Agriculture Bulletin No. 84. | Ditto | Ditto |
| 55 | A Summary of the Results of the Experiments on Paddy conducted at the Mangalnallur Agricultural Station. Madras Department of Agriculture Bulletin No. 85. | N. S. Kulandai Swami Pillai. | Ditto |
| 56 | A Short-Note on the Sirvel Agricultural Station. Madras Department of Agriculture Leaflet No. 18. | Issued by the Department of Agriculture, Madras. | Ditto |
| 57 | How to Produce Kolingi by Ryots in the IV Circle, comprising the districts of North Arcot, South Arcot, Chingleput and Chittoor. Madras Department of Agriculture Leaflet No. 19. | Ditto | Ditto |
| 58 | A Short Note on the Bantanahal Agricultural Station. Madras Department of Agriculture Leaflet No. 20. | Ditto | Ditto |
| 59 | Tillage. Madras Department of Agriculture Leaflet. | Ditto | Ditto |
| 60 | The Soil. Madras Department of Agriculture Leaflet. | Ditto | Ditto |
| 61 | Agricultural Meteorology. Madras Department of Agriculture Leaflet. | Ditto | Ditto |
| 62 | The relations existing between the Research Institute, the Agricultural Stations and the Ryots. Madras Department of Agriculture Leaflet No. 21. | Ditto | Ditto |
| 63 | Bone Crushing Mill. Madras Department of Agriculture Leaflet No. 22. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** | | |
| 64 | The [illegible]ral College. Madr[illegible]tment of Agricultu[illegible]flet No. 23. | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 65 | A Scheme for the distribution of breeding bulls. (In vernaculars only.) Madras Department of Agriculture Leaflet No. 24. | Ditto | Ditto |
| 66 | The Sindewahi Furnace for Jaggery Manufacture. Madras Department of Agriculture Leaflet No. 25. | Ditto | Ditto |
| 67 | A Note on the Demonstration of Agricultural Improvements carried in V Circle (Tanjore and Trichinopoly) during the first crop season in 1922-23. Madras Department of Agriculture Leaflet No. 27. | Ditto | Ditto |
| 68 | Note on the Agricultural Middle School at Anakapalle. (In Telugu only.) Madras Department of Agriculture Leaflet No. 28. | Ditto | Ditto |
| 69 | Note on the improved methods of paddy and sugarcane cultivation. (In Telugu only.) Madras Department of Agriculture Leaflet No. 29. | Ditto | Ditto |
| 70 | A Popular Account of the work of the Madras Agricultural Department. | Ditto | Ditto |
| 71 | Report on the working of the Department of Agriculture, Central Provinces and Berar, 1921-22. Price R. 1. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Nagpur. |
| 72 | Report on the Agricultural College, Nagpur, Botanical, Chemical and Mycological Research, Maharaj Bagh Menagerie and Agricultural Engineer's Section for 1921-22. Price As. 8. | Ditto | Ditto |
| 73 | Season and Crop Report of the Central Provinces and Berar for 1921-22. Price As. 8. | Issued by the Department of Land Records, Central Provinces. | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 74 | Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1921-22. Price As. 8. | Issued by the Department of Agriculture, Central Provinces and Berar. | [redacted] Press, |
| 75 | Report on Agricultural Stations, Northern Circle, Central Provinces, for 1921-22. Price As. 8. | Ditto | Ditto |
| 76 | Report on Demonstration Work in the Northern Circle, Central Provinces, for 1921-22. Price As. 8. | Ditto | Ditto |
| 77 | Report on Agricultural Stations, Southern Circle, Central Provinces, for 1921-22. Price Rs. 2. | Ditto | Ditto |
| 78 | Report on Demonstration Work in the Southern Circle, Central Provinces, for 1921-22. Price As. 8. | Ditto | Ditto |
| 79 | Report on the Agricultural Stations, Western Circle, Central Provinces, for 1921-22 Price As. 8. | Ditto | Ditto |
| 80 | Report on Demonstration Work in the Western Circle, Central Provinces, for 1921-22. Price As. 8. | Ditto | Ditto |
| 81 | Report on Agricultural Stations, Eastern Circle, Central Provinces, for 1921-22. Price Rs. 2. | Ditto | Ditto |
| 82 | Report on Demonstration work in the Eastern Circle, Central Provinces, for 1921-22. Price As. 8. | Ditto | Ditto |
| 83 | Return of expenditure on the Provincial and District Gardens in the Central Provinces and Berar for the year ending 30th June, 1922. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | GENER[redacted]ULTURE | | |
| 84 | The M[redacted]rops based on the [redacted] Experimental Work[redacted] the last 15 years on Government Farms. Central Provinces Department of Agriculture Bulletin No. 14. Price As. 2. | R. G. Allan, M.A., Principal, Agricultural College, Nagpur. | Government Press, Nagpur. |
| 85 | Ensilage. Central Provinces Department of Agriculture Bulletin No. 17 (in English, Hindi and Marathi). Price A. 1. | S. T. D. Wallace, B.SC., Deputy Director of Animal Husbandry, Central Provinces. | Ditto |
| 86 | The Consolidation of Holdings in its Relation to Conditions in Chhattisgarh. Central Provinces Department of Agriculture Bulletin No. 18. Price As. 2. | J. C. MacDougall, M.A., B.SC., Officiating Deputy Director of Agriculture, Eastern Circle, Central Provinces. | Ditto |
| 87 | Import of Cattle for Draught and Dairying. Central Provinces Department of Agriculture Leaflet in English, Hindi and Marathi (for free distribution). | Issued by the Department of Agriculture, Central Provinces and Berar. | Ditto |
| 88 | Annual Report of the Department of Agriculture, Assam, for the year ending 31st March, 1922. Price As. 8. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 89 | Report of the Agricultural Experiments and Demonstrations in Assam for the year ending 31st March, 1922. Price As. 12. | Ditto | Ditto |
| 90 | Tables of Agricultural Statistics of Assam for the year 1921-22. | Ditto | Ditto |
| 91 | Report on Agricultural Demonstrations in the Surma Valley Circle for the year ending 31st March, 1922. | Ditto | Ditto |
| 92 | Report on Agricultural Demonstrations in the Assam Valley Circle for the year ending 31st March, 1922. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 93 | How to can fruits and vegetables at home. (In English and Bengali.) Assam Department of Agriculture Leaflet No. 1 of 1923. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 94 | Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1922. Price, R. 1. | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |
| 95 | Season and Crop Report of Burma for 1921-22. Price, R. 1. | Issued by the Department of Settlements and Land Records, Burma. | Ditto |
| 96 | Report of the Agricultural Chemist, Burma, for the year ended the 30th June, 1922. Price, As. 4. | Issued by the Department of Agriculture, Burma. | Ditto |
| 97 | Report of the Economic Botanist, Burma, for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 98 | Report of the Assistant Director of Agriculture (Entomology), Burma, for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 99 | Report of the Agricultural Engineer, Burma, for the year ended the 30th June, 1922. Price, As. 8. | Ditto | Ditto |
| 100 | Report on Sericultural Work for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 101 | Report on the Pump Irrigation at Chaungu (Sagaing), 1921-22. Price, As. 4. | Ditto | Ditto |
| 102 | Report on the Mandalay Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 103 | Report on the Allanmyo Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*contd.* | | |
| 104 | Report on the Hopin Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Issued by the Department of Agriculture, Burma. | Government Printing, Burma, Rangoon. |
| 105 | Report on the Padu Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 106 | Report on the Yawnghwe Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 107 | Report on the Tatkon Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 108 | Report on the Hmawbi Agricultural Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 109 | Report on the Mahlaing Cotton Experimental Station for the year ended the 30th June, 1922. Price, As. 4. | Ditto | Ditto |
| 110 | Agricultural Calendar for 1923-24 (in Burmese). | Ditto | Ditto |
| 111 | Report of the Agricultural Stations at Tarnab and Haripur in the North-West Frontier Province for the two years ending 30th June, 1922. | Issued by the Department of Agriculture, North-West Frontier Province. | Government Press, Peshawar. |
| 112 | Report on the Season and Crops of the North-West Frontier Province for 1921-22. Price, R. 1-4-0. | Revenue Commissioner, North-West Frontier Province. | Ditto |
| 113 | Summary of Remarks on the Kharif Crop of the North-West Frontier Province for 1921-22. Price, As. 7. | Ditto | Ditto |
| 114 | Report on the Operations of the Department of Agriculture and Fisheries, Travancore, for 1921-22. | Issued by the Department of Agriculture and Fisheries, Travancore. | Government Press, Trivandrum. |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** —*concld.* | | |
| 115 | Report on the Administration of the Village Panchayats and Department of Agriculture in the Cochin State for the year 1921-22. | Issued by the Department of Agriculture, Cochin. | Government Press, Ernaculam. |
| 116 | Annual Report of the Agricultural Department, Gwalior State, for 1921-22. | Issued by the Department of Agriculture, Gwalior. | Alijah Darbar Press, Lashkar. |
| 117 | Annual Report of the Agricultural Department, Mysore, for the year 1921-22. | Issued by the Department of Agriculture, Mysore. | Government Press, Bangalore. |
| 118 | Annual Report of the Department of Agriculture, Baroda State, for the year 1920-21. Price, R. 1. | Issued by the Department of Agriculture, Baroda. | Baroda Printing Office, Baroda. |
| 119 | *Quarterly Journal of the Indian Tea Association*, Price, As. 6 per copy. | Issued by the Scientific Department of the Indian Tea Association, Calcutta. | Catholic Orphan Press, Calcutta. |
| 120 | The *Journal of the Madras Agricultural Students' Union* (Quarterly). Annual Subscription Rs. 2. | Madras Agricultural Students' Union, Coimbatore. | Literary Sun Press, Coimbatore. |
| 121 | *Indian Scientific Agriculturist*. Annual subscription Rs. 4. | Alliance Advertising Association, Ltd., Calcutta. | Messrs. Bera & Co., Printers, Calcutta. |
| 122 | *Poona Agricultural College Magazine* (Quarterly). Annual subscription Rs. 2. | College Magazine Committee, Poona. | Arya Bhusan Press, Poona. |
| 123 | The *Planters' Chronicle* (Weekly). Price, As. 8 per copy. | United Planters' Association of South India, Coimbatore. | Daily Post Press, Bangalore. |
| 124 | *Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription Rs. 3. | Mysore Agricultural Experimental Union. | Bangalore Press, Bangalore. |
| | **AGRICULTURAL CHEMISTRY.** | | |
| 125 | Investigations on Indian Opium, No. 3. Studies in the Meconic Acid Content of Indian Opium. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 6. Price, As. 6 or 6*d*. | Harold E. Annett, D.Sc. (Lond.), F.I.C., M.S.E.A.C., Agricultural Chemist, Cawnpore, and Mathura Nath Bose, M.A. | Messrs. Thacker, Spink & Co., Calcutta. |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **AGRICULTURAL CHEMISTRY** —*concld.* | | |
| 126 | Chemical Studies on Safflower Seed and its Germination. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 7. Price, As. 10 or 1*s.* | V. A. Tamhane, M.Sc., M.Ag., Soil Physicist to Government, Bombay. | Messrs Thacker, Spink & Co., Calcutta. |
| 127 | Note on the Permanent Manurial Plots, Coimbatore. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 8. Price, R. 1-4 or 1*s.* 9*d.* | Roland V. Norris, D.Sc., Government Agricultural Chemist, Coimbatore. | Ditto |
| 128 | A Note on Hydrocyanic Acid in the Burma Bean (*Phaseolus lunatus* sp). Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VII, No. 1. Price, As. 12 or 1*s.* | F. J. Warth, B.Sc., M.Sc., Physiological Chemist, Pusa. | Ditto |
| 129 | Studies of an Acid Soil in Assam, II. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VII, No. 2. Price, As. 12 or 1*s.* | A. A. Meggitt, B.Sc., F.C.S., Agricultural Chemist, Assam. | Ditto |
| 130 | The Hydrogen Ion Concentrations of Some Indian Soils and Plant Juices. Pusa Agricultural Research Institute Bulletin No. 136. Price, As. 4. | W. R. G. Atkins, O.B.E., Sc.D., F.I.C., Formerly Indigo Research Botanist to the Government of India. | Government Printing, India, Calcutta. |
| 131 | The Determination of Prussic Acid in Burma Bean (*Phaseolus lunatus*). Pusa Agricultural Research Institute Bulletin No. 140. Price, As. 3. | J. Charlton, B.Sc., Agricultural Chemist, Burma. | Ditto |
| 132 | The Nature of Changes occurring in the Indigo Steeping Vat. Indigo Publication No. 11. Price, R. 1-10. | W. A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist to the Government of India. | Ditto |
| | **BOTANY.** | | |
| 133 | The Inheritance of Characters in Rice, II. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 8. Price, R. 1-4 or 1*s.* 8*d.* | F. R. Parnell, M.A., Ag. Dip. (Cantab.), Government Economic Botanist, Madras, with the assistance of G. N. Rangaswami Ayyangar, B.A., K. Ramiah, L.Ag., and C. R. Srinivasa Ayyangar, L.Ag. | Messrs. Thacker Spink & Co., Calcutta. |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **BOTANY**—*concld.* | | |
| 134 | The Wheats of Bihar and Orissa. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XII, No. 1. Price, As. 8 or 9*d*. | Albert Howard, C.I.E., M.A., Imperial Economic Botanist, Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist, and Abdur Rahman Khan, Second Assistant to the Imperial Economic Botanist. | Messrs. Thacker, Spink & Co., Calcutta. |
| 135 | Note on the Probability of an Inter-relation between the Length of the Stigma and that of the Fibre in some forms of the genus *Gossypium*. Pusa Agricultural Research Institute Bulletin No. 137. Price, As. 4. | Ram Prasad, Officiating Assistant Economic Botanist, United Provinces. | Government Printing, India, Calcutta. |
| | **MYCOLOGY.** | | |
| 136 | A New Ginger Disease in Godavari District. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 9. Price, R. 1 or 1*s*. 4*d*. | S. Sundararaman, M.A., Government Mycologist, Madras. | Messrs. Thacker, Spink & Co., Calcutta. |
| 137 | *Helminthosporium* spp. on Cereals and Sugarcane in India, Part I. (Diseases of *Zea Mays* and *Sorghum vulgare* caused by species of *Helminthosporium*.) Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 10. Price, R. 1 or 1*s*. 4*d*. | M. Mitra, M.Sc., First Assistant to the Imperial Mycologist. | Ditto |
| 138 | I. History of the Operations against Bud Rot of Palms in South India. II. Inoculation Experiments with *Phytophthora palmivora* Butl. on *Borassus flabellifer* Linn. and *Cocos nucifera* Linn. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XII, No. 2. Price, R. 1-4 or 2*s*. | W. McRae, M.A., B.Sc., Acting Imperial Mycologist. | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **MYCOLOGY**—*concld.* | | |
| 139 | Red rot disease (Saru or Soka) in thick sugarcane. Punjab Department of Agriculture Leaflet No. 18. (Revised, 1923.) | D. Milne, B.Sc., Economic Botanist, Punjab. | Government Printing, Punjab, Lahore. |
| 140 | Treatment of Smut by Copper Sulphate. Madras Department of Agriculture Leaflet No. 26. (In Telugu.) | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| | **ENTOMOLOGY** | | |
| 141 | Notes on Indian Diptera: (1) Diptera from the Khasia Hills, (2) Tabanidæ in the collection of the Forest Zoologist, and (3) New Species of Diptera from the Indian Region. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 9. Price, R. 1-12 or 2*s.* 3*d.* | Ronald Senior-White, F.E.S., Malariologist, The Kepitigalla Rubber Estates, Ltd. | Messrs. Thacker, Spink & Co., Calcutta. |
| 142 | *Platyedra gossypiella*, Saund., The Pink Boll-worm, in South India, 1920-21. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 10. Price, As. 12 or 1*s.* | E. Ballard, B.A., F.E.S., Government Entomologist, Madras. | Ditto |
| 143 | Studies in Indian Dermaptera. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 11. Price, R. 1-4 or 1*s.* 9*d.* | Morgan Hebard. | Ditto |
| 144 | Further Notes on *Pempheres affinis*, Fst. (The Cotton Stem Weevil). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 12. Price, R. 1 or 1*s.* 4*d.* | E. Ballard, B.A., F.E.S., Government Entomologist, Madras. | Ditto |
| 145 | An Account of Experiments on the Control of *Siga* (*Schœnobius*) *incertellus* in the Godavari Delta. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 13. Price, As. 14 or 1*s.* 4*d.* | E. Ballard, B.A., F.E.S., Government Entomologist, Madras. | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY**—*contd.* | | |
| 146 | No. 1—*Hydrophilidæ* of India (Col.). A List of the Species in the Collection of the Agricultural Research Institute, Pusa (Bihar). | A. d'Orchymont. | Messrs. Thacker, Spink & Co., Calcutta. |
| | No. 2—An Annotated List of Ichneumonidæ in the Pusa Collection. | G. R. Dutt, B.A., Personal Assistant to the Imperial Entomologist. | |
| | No. 3—A Second Note on Odonata in the Pusa Collection. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VIII, Nos. 1, 2 and 3. Price, R. 1 or 1*s.* 6*d.* | Major F. C. Fraser, I.M.S. | |
| 147 | Notes on Indian Muscidæ—1. *Calliphorinæ Testaceæ.* 2. *Rhiniinæ.* Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VIII, No. 4. Price, As. 12 or 1*s.* | Ronald Senior-White, F.E.S., Malariologist, The Kepitigalla Rubber Estates, Ltd., Ceylon. | Ditto |
| 148 | An Entomologist's Crop Pest Calendar for the Madras Presidency. Pusa Agricultural Research Institute Bulletin No. 131. Price, As 2. | T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Assistant Entomologist, Madras. | Government Printing, India, Calcutta. |
| 149 | Report of Campaign against *Spodoptera mauritia,* Boisd. (*Noctuidæ*) in Malabar. Pusa Agricultural Research Institute Bulletin No. 132. Price, As. 2. | E. Ballard, B.A., F.E.S., Government Entomologist, Madras. | Ditto |
| 150 | Results of Investigation of Bionomics of *Platyedra gossypiella,* Saunders, in South India, together with some Notes on *Earias insulana* and *E. fabia.* Pusa Agricultural Research Institute Bulletin No. 133. Price, As. 5. | Ditto | Ditto |
| 151 | Supplementary Observations on Borers in Sugarcane, Rice, etc. Pusa Agricultural Research Institute Bulletin No. 134. Price, As. 6. | C. C. Ghosh, B.A., Assistant Entomologist, Burma. | Ditto |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY**—*concld.* | | |
| 152 | Some Observations on the Control of Field Rats in the Punjab. Pusa Agricultural Research Institute Bulletin No. 135. Price, A. 1. | M. A. Hussain, M.A., Government Entomologist, Punjab, and Hem Singh Pruthi, M.Sc., Assistant Professor of Entomology, Punjab. | Government Printing, India, Calcutta. |
| 153 | List of Publications on Indian Entomology, 1920-21. Pusa Agricultural Research Institute Bulletin No. 139. Price, R. 1. | Compiled by the Imperial Entomologist. | Ditto |
| 154 | The Cultivation of Lac in the Plains of India (*Tachardia lacca*, Kerr). Pusa Agricultural Research Institute Bulletin No. 142. Price, R. 1-8. | Rai Bahadur C. S. Misra, B.A., First Assistant to the Imperial Entomologist. | Ditto |
| 155 | Ber (*Zizyphus jujuba*) Fruit and its Fly Pest. Pusa Agricultural Research Institute Bulletin No. 143. Price, As. 6. | J. L. Khare, F.E.S., Lecturer in Entomology, Agricultural College, Nagpur. | Ditto |
| 156 | Report on the Diseases of Silkworms in India. Price, Rs. 3. | A. Pringle Jameson, D.Sc. | Ditto |
| 157 | Catalogue of Indian Insects. Part 2—Culicidæ. Price, R. 1-10. | Ronald Senior-White, F.E.S., Malariologist, The Kepitigalla Rubber Estates, Ltd., Ceylon. | Ditto |
| 159 | Catalogue of Indian Insects. Part 3—Bombyliidæ. Price, As. 8. | Ditto | Ditto |
| 160 | List of Important Insects injurious to cultivated crops in South India. Madras Department of Agriculture Bulletin No. 86. | T. V. Ramakrishna Ayyar, Assistant Entomologist, Madras. | Government Press, Madras. |
| | **AGRICULTURAL BACTERIOLOGY.** | | |
| 161 | Comparative Manurial Value of the Whole Plants and the Different Parts of Green Manures. Pusa Agricultural Research Institute Bulletin No. 141. Price, As. 6. | N. V. Joshi, B.A., M.Sc., L.Ag., First Assistant to the Imperial Agricultural Bacteriologist. | Government Printing, India, Calcutta. |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **AGRICULTURAL BACTERIOLOGY**—*concld.* | | |
| 162 | Some Observations on Barren Soils of Lower Bari Doab Colony in the Punjab. Pusa Agricultural Research Institute Bulletin No. 145. Price, As. 3. | S. M. Nasir, Bacteriological Assistant to the Agricultural Chemist, Punjab. | Government Printing, India, Calcutta. |
| | **VETERINARY.** | | |
| 163 | Annual Report of the Imperial Bacteriological Laboratory, Muktesar, for the year ending 31st March, 1922. Price, As. 9. | Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar. | Ditto |
| 164 | Studies in Rinderpest. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. III, No. 4. Price, R. 1 or 1*s.* 4*d.* | W. A. Pool, M.R.C.V.S., Officiating Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, and T. M. Doyle, F.R.C.V.S., Veterinary Officer, Imperial Bacteriological Laboratory, Muktesar. | Messrs. Thacker, Spink & Co., Calcutta. |
| 165 | Etiology of Equine Contagious Abortion in India. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. III, No. 5. Price, As. 8 or 9*d.* | T. M. Doyle, F.R.C.V.S., Veterinary Officer, Imperial Bacteriological Laboratory, Muktesar. | Ditto |
| 166 | Observations on the Morphology and Life-Cycle of *Filaria recondita* Grassi. Pusa Agricultural Research Institute Bulletin No. 144. Price, As. 6. | M. Anant Narayan Rao, Acting Assistant Professor, Madras Veterinary College. | Government Printing, India, Calcutta. |
| 167 | Annual Report of the Bengal Veterinary College and of the Civil Veterinary Department, Bengal, for 1921-22. Price, R. 1. | Issued by the Civil Veterinary Department, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 168 | Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1921-22. Price, R. 1-8. | Issued by the Civil Veterinary Department, Bihar and Orissa. | Government Printing, Bihar and Orissa, Patna. |

*List of Agricultural Publications in India during 1922-23*—contd.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*contd.* | | |
| 169 | A Note on Flaying of Goats Alive. | Rai Sahib P. N. Das, G.B.V.C., Assistant Director, Civil Veterinary Department, Bihar and Orissa. | Government Printing, Bihar and Orissa, Patna. |
| 170 | Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1922. Price, R. 1-2. | Issued by the Civil Veterinary Department, United Provinces. | Government Press, United Provinces, Allahabad. |
| 171 | Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for the year 1921-22. Price, As. 11. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 172 | Annual Report of the Camel Specialist for 1921-22. Price, As. 3. | Ditto | Ditto |
| 173 | Surra Transmission Experiments. Punjab Veterinary Bulletin No. 5 of 1921. | H. E. Cross, I.C.V.D., Camel Specialist, Punjab, and P. G. Patel. | Ditto |
| 174 | Transmission of Surra by *Tabanus nemocallosus*. Punjab Veterinary Bulletin No. 7 of 1921. | Ditto | Ditto |
| 175 | Camel Surra. Punjab Veterinary Bulletin No. 8 of 1922. | Ditto | Ditto |
| 176 | Argasidæ found in the Punjab. Punjab Veterinary Bulletin No. 9 of 1922. | Ditto | Ditto |
| 177 | Caponing of Fowls (Vernacular). Punjab Veterinary Bulletin No. 10 of 1922. | Abdullah Khan, Veterinary Assistant under Camel Specialist, Punjab. | Ditto |
| 178 | Treatment of Surra by Tartar Emetic (Vernacular). Punjab Veterinary Bulletin No. 11 of 1922. | Ditto | Ditto |
| 179 | Surra Transmission Experiments with *Tabanus allimedius* and Ticks. Punjab Veterinary Bulletin No. 12 of 1923. | Issued by the Department of Agriculture, Punjab. | Ditto |

*List of Agricultural Publications in India during 1922-23*—concld.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **VETERINARY**—*concld.* | | |
| 180 | List of Horse shows and Cattle Fairs in the Punjab and Native States during 1922-23. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 181 | Annual Administration Reports of the Bombay Veterinary College and Civil Veterinary Department, Bombay Presidency, for 1921-22. | Issued by the Civil Veterinary Department, Bombay | Government Central Press, Bombay. |
| 182 | Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1921-22. Price, As. 3. | Issued by the Civil Veterinary Department, Madras. | Government Press, Madras |
| 183 | Anthrax. Madras Civil Veterinary Department Leaflet No. 6. | Ditto | Ditto |
| 184 | Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1921-22. Price, R. 1 | Issued by the Civil Veterinary Department, Central Provinces. | Government Press, Nagpur. |
| 185 | Report of the Civil Veterinary Department, Assam, for 1921-22. Price, As. 8. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 186 | *Report of the Civil Veterinary* Department (including the Insein Veterinary School), Burma, for the year ending 31st March, 1922. Price, R. 1. | Issued by the Civil Veterinary Department, Burma. | Government Printing Burma, Rangoon. |

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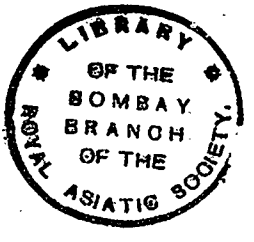
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